THE

POPULAR SCIENCE MONTHLY.

JANUARY, 1883.

THE GREAT COMET OF 1882.

By Professor C. A. YOUNG.

THE comet which is fading in the morning sky is one of the most interesting that has ever appeared. Few, if any, have ever been more brilliant, and though others have been larger, and have continued visible for a longer time, none of them have presented more remarkable phenomena.

Of late we have been much favored in the matter of bright comets. According to the list given by Humboldt in his "Cosmos," it appears that the average interval between such apparitions for the last five centuries has been something like eight years. During the last fifty years the frequency has been about the same, conspicuous comets having appeared in 1835, 1843, 1858, 1861, 1862, and 1874. But since the beginning of 1880 we have already had five which were visible to the naked eye, and three of them comets of the highest rank. The comet of 1880 was indeed visible only in the southern hemisphere; but we all remember the fine comet which appeared in June, 1881, and was not much, if at all, inferior to the present one. Schäberle's comet, which followed in August, would have been regarded as very satisfactory had its predecessor been less brilliant; and Wells's comet of last summer, though not well seen in the United States, was a very respectable comet in South Africa.

It is not yet certain when or where the present comet was first seen, but, so far as now appears, the priority belongs to Dr. Gould, or one of his assistants, at the observatory of Cordoba in South America. In a private letter to Mr. Chandler, of Cambridge, mainly occupied with other matters, Dr. Gould, under date of September 15th, mentions that a brilliant comet had been visible there near the celestial equator for "more than a week": he had already two observations, and was

waiting for clear weather again in hopes of being able to catch it on the meridian. This would put its discovery on or before September 7th. It was seen on the 8th by Mr. Finlay, an assistant in the Royal Observatory at the Cape of Good Hope; and on the 12th it was observed at Rio Janeiro, by Cruls, who telegraphed the news to Europe, announcing it (erroneously) as the expected comet of 1812 on its return. We have not yet sufficiently full accounts from the southern observatories to know whether it was lost sight of at all after its discovery, but we have the account of a most interesting and unprecedented observation made at the Cape Town Observatory, on the 17th. Mr. Gill, the director of the observatory, writes: "The comet was followed by two observers with separate instruments right up to the sun's limb, where it suddenly disappeared at $4^h\ 50^m\ 58^s$ local mean time." This was about an hour and a half before its perihelion passage.

A few hours previously it had been independently discovered by Mr. Common in England, in the full blaze of sunlight, and clouds alone prevented him from making the same observation as Mr. Gill.

It is evident that the comet must have been most intensely brilliant to be visible under such circumstances. When it passed on to the sun's disk (it was between us and the sun at the time), it disappeared, being either transparent, or else practically as bright as a portion of the sun's own surface. If this comet had been in the place of the little "Tewfik" which was seen close to the sun at the time of the Egyptian eclipse last May, it would have been something to remember.

On September 18th the comet had reached a greater distance from the sun (about 3°), and had become so conspicuous that it was simultaneously rediscovered by a multitude of observers in all parts of the world, and accurate determinations of its position were made at several observatories. On the next day every one had heard of it, and people interested in astronomy thought and talked of nothing else.

On the 19th and 20th the comet was still easily seen by the naked eye. On the 21st it was visible only in places when the air was very clear, and the sky darkly blue. On the 22d a curious observation of it was made at Paris by M. Mallet, who, at the request of M. de Fonvielle, ascended for the purpose in a balloon provided by the latter, thus getting above the clouds with which the city was thickly covered. Of course, it was not possible in this manner to make any precise determination of position, but the aëronaut obtained a fine view of the celestial visitor.

For a few days after this the comet does not appear to have been observed until it had receded far enough from the sun to become visible before sunrise. Then, for a while, during the early days of October, it was a most magnificent object, with a head at first rivaling Jupiter in brightness, and a tail which, though not of unusual dimensions, never much exceeding 60,000,000 miles, was remarkably well defined, dense, and luminous. It moved slowly toward the south and

west, and when, once in a while, a clear morning permitted the view, it was seen to be growing fainter and more diffuse, though not smaller.

To the naked eye or opera-glass it has perhaps presented fewer phenomena of interest than some other comets—that of 1858, for instance; it has not exhibited any of the peculiar secondary tails or straight streamers which were so characteristic of that comet, nor has the striation of the tail been marked, though evident enough on close inspection.

From September 27th to October 1st, however, the tail was "rifted." There was one obscure streak extending from the nucleus through its whole length, described both by Ricco, of Palermo, and Dr. Hastings, of Baltimore, and the latter mentions another fainter one parallel to the first, and shorter.

On October 2d the tail, as seen at Princeton, was about 14° long, exceedingly bright and sharp in its outlines, slightly curved and convex to the horizon. It was especially well defined near the head, and almost equally so on both sides. On the 4th the upper edge was veiled and rendered indefinite by a faint nebulosity which appeared to have emanated from the head. Ricco's drawing of it, as seen at this date in the clear Italian sky, shows something resembling a bright comet, enveloped in a fainter one; but the smaller one is eccentric, and south of the middle of the hazy envelope.

On the 10th this external nebulosity had considerably increased. Professor Smith, of Kansas University, noticed on the 9th a pale stream of light with parallel edges, and nearly as wide as the tail of the comet, extending toward the sun. On the 15th the phenomenon had become much more conspicuous. The streamer was now over half a degree in width, well defined at both edges, of nearly uniform brightness throughout, though nowhere as bright as even the faintest portions of the tail, and extended from its origin, a degree or two above the nucleus, to a distance of two or three degrees below the head, where it faded out. The dotted lines in Fig. 1 indicate its form and dimensions.

FIG. 1.—OCTOBER 15, 1882.

This streamer, which remained visible only a few days, may have originated in the enveloping comet of Ricco's figure just spoken of, but no other comet is known to have shown anything of the kind. It is not to be confounded with the sunward jets sometimes ejected by cometary nuclei, nor did it at all resemble the anomalous tail, directed toward the sun, shown by Pechüle's comet (in December, 1880), in addition to its ordinary tail.

On October 9th, Schmidt, of Athens, announced the discovery of a small companion comet, 4° southwest of the large one, and moving parallel with it. So far as we know, no one else has observed this companion, though it was carefully looked for at Washington, Princeton, and elsewhere. On October 21st, however, Mr. Brooks, of Phelps, New York, observed either the same or another one, some 8° south and east from the large comet. Like Schmidt's companion it was very faint (though large), and we have seen no observations of it from other sources. We have no means of ascertaining whether these attendants accompanied the comet on its way to the sun as separate objects, or whether they are fragments detached from the main body.

Mr. Brooks seems to think that the nebulous mass observed by him was in some way connected with the faint envelope and streamer just spoken of, which is not unlikely.

When the writer first saw the comet, on September 19th, it was impossible, with the great twenty-three-inch equatorial, to make out much except the nucleus itself. The comet was so near the sun that the object-glass could not be screened from the direct sunshine, which filled the whole field with glaring light. The finder of the instrument is itself, however, a powerful telescope of five inches aperture, and this was perfectly screened by the great tube, so that it furnished an admirable view of the beautiful object. To the naked eye the comet looked like some white-winged bird in swift flight toward the sun. The telescope showed the wings to be long, curved streams flowing backward from each side of the head—backward, that is, with reference to the sun; but they were, of course, really in advance of the comet, which at this time was receding from the sun. The head of the comet had for its center a small round and brilliant nucleus, not well defined, but rather a nebulous star, some 4″ in diameter; in front of this at a distance of perhaps 30′ was an "envelope," and there was a second one at a distance of 2′ or 3′. They were connected by a pair of eccentric circular arcs, and these arcs, coalescing with the outer envelope and prolonged, formed the skeleton of the "wings." Back of the nucleus, traces of the usual dark stripe could be detected. Fig. 2 presents the main features in outline, and every one will notice its close resemblance to Brodie's picture of Coggia's comet as seen on July 13, 1874. (The picture alluded to forms the frontispiece of Chambers's "Descriptive Astronomy," third edition.)

FIG. 2.—HEAD OF COMET SEPTEMBER 19—5-INCH TELESCOPE.

On the next day the comet was seen at Princeton for a few mo-

ments through clouds, just long enough to get imperfect observations for position, but nothing more. It was noticed, however, that the eccentric arcs had disappeared. On October 2d the comet was observed for more than an hour before daybreak with the great telescope. The most notable features were a single bright cap or envelope at a distance of about half a minute from the nucleus, and the nucleus itself, which, instead of being round, was considerably elongated. There were, however, no jets, or starfish-like projections such as the comet of 1881 presented so often. There was not much of structural detail to be made out in the head of the comet, but the dark stripe behind the nucleus was very conspicuous. This dark stripe, by-the-way, is a very remarkable phenomenon, not yet explained, so far as we know, though observed in most large comets. The common impression is, that it is merely a space behind the nucleus, screened as it were by the nucleus itself, from the rush of luminous matter which is being driven backward by the sun's repulsion. But if this be so, then, as Mr. Proctor has pointed out, in a recent article, there is no reason why it should appear so well defined and so dark. The cross-section of the tail, a little way behind the nucleus, was, in the present case at least, 100,000 miles in diameter: now, merely taking away the luminous matter from a tunnel 6,000 or 8,000 miles in diameter along the axis of the tail, could make but little difference with the amount of light received by the eye at a distance. If there were no tunnel, we should get from the central line of the tail the brightness corresponding to a thickness of 100,000 miles of luminous matter. Boring the tunnel would only reduce it to some 90,000 miles, and the difference would be hardly perceptible.

It seems more likely, if the writer may venture the suggestion, that the stripe is a stream or beam of non-luminous, cooler vapor or gas, which is nearly opaque to the radiation emitted by the same kind of gas when luminous, and therefore cuts off all the light from whatever portions of the comet's luminous drapery is behind it; in the same way that cool sodium-vapor, for instance, is relatively opaque to the light of a sodium-flame. If this is correct, the dark stripe ought not to be black, but just about half as bright as the neighboring nebulosity; which corresponds to the actual fact. If one could catch a star passing behind the stripe, it would perhaps be easy to settle the question. At any rate, if the star shone more brightly when in the stripe, we might be sure that the hypothesis is wrong. The star should be dimmed a little, if anything, though, of course, *star*-light would not be so much affected as the light from cometary matter. Mr. Proctor has suggested a different hypothesis, which seems to the writer rather less probable, but there is no time to discuss it here.

On October 4th the nucleus had become much more elongated, so as to be shaped something like an Indian club. The envelope, which was conspicuous on the 2d, had disappeared, or degenerated

into an indefinite nebulosity, and the dark stripe had become much fainter.

Continued bad weather prevented observation until the 10th, and on this date the nine-and-a-half-inch telescope of the School of Science Observatory was used. A great change had taken place. The nucleus had become an irregular, spindle-shaped streak some 40″ long, made up of six or eight star-like knots of luminosity connected and veiled by shining haze. One of these knots, about a third of the way from the sunward extremity, was considerably larger and brighter than any of the others, and should, perhaps, be considered as the true nucleus. The next one beyond it (reckoning from the direction of the sun) was second in size, and separated by an interval of 2″ or 3″, the space being filled, however, with nebulosity. The dark stripe was still visible, but directed, not along the prolongation of the nuclear streak, but inclined at an angle of 8° or 10°, while a *bright* jet from the nucleus, two or three minutes in length, touched one side of the dark stripe, and kept nearly in the axis of the tail.

Fig. 3 is an attempt to illustrate the appearance and relation of things by a mere outline sketch, which, of course, can not be considered in any sense a *representation*, since it fails entirely to give an idea of the shading and gradation of light. The head of the comet presented no definite outline whatever, and the nucleus very little. The knots were mere condensations of brightness in the midst of diffuse light. When the dawn came on, the fainter parts successively disappeared, so that at a certain stage the nucleus seemed to be divided into two portions. A small telescope would probably show things in the same way even before dawn, and this is undoubtedly the origin of the reports that the comet had split in two.

Fig 3.—Head of Comet October 10, 1882.

This great and unprecedented elongation of the nucleus is a most remarkable phenomenon. If it had occurred at or near the time of perihelion passage, it might have been naturally attributed to the divellent action of the sun's attraction; but it is a little difficult to see why the thing should have pulled out and come to pieces in such a way after getting safely by the crisis. It is worth noting that this peculiarity of the comet adds greatly to the difficulty of making accurate observations of its position: one does not know just upon what point to direct his instrument.

Continuous cloudy weather prevented any observation of the comet until the 15th. On that date the appearance of things as seen in the

great equatorial was very much what it had been on the 10th with the smaller telescope. There were no envelopes, and the only "jet" was the bright streak following the nucleus. The dark stripe had wholly disappeared, as if obliterated and replaced by the bright one. The "knots" in the nucleus were seen to be irregular in form, and were arranged not in a straight line, but in a somewhat broken curve, conforming to the curvature of the tail, which at this time extended 18°, and was fully 60,000,000 miles in length. The bright stream originated not at the extremity of the nucleus, but came out tangentially from the convex side, and perhaps had its source in the largest of the knots, which was now the third from the sunward extremity. The whole length of the nucleus measured 48½″, corresponding to a length of more than 40,000 miles, the diameter of the largest single mass being about 5,000 or 6,000 miles. The only other observation we have been able to make at Princeton was nine days later, on October 24th. No material changes were noticed, though the comet was very much fainter. The same lengthened granular nucleus continued, and seems likely to persist until the comet disappears.*

The spectroscopic observations have been very interesting. On September 18th the French physicist Thollon was an independent discoverer of the comet, coming upon it accidentally in sweeping around the sun. His spectroscopic apparatus consists of a so-called siderostat, the mirror of which throws the rays from the object to be examined upon the lens of a horizontal telescope nine and a half inches in diameter and about twenty feet long. At the focus of this telescope in a darkened room is placed a spectroscope, and, of course, this may be of any form and power best suited to the occasion. In the present case he used an instrument with a single prism of high dispersive power. The most marked feature of the spectrum was the presence of the lines of sodium in the spectrum of the nucleus. They were very bright, and were displaced toward the red by an amount equal to about one fourth of the interval between them, thus indicating that the comet was rapidly receding from the earth. A very narrow, bright, continuous spectrum was also shown by the nucleus. In this the dark lines of Fraunhofer were not conspicuous if visible at all,

* Later observations, on November 4th, show the same general characteristics. The nucleus, if it can be so called, was now 93″ in length, or more than 90,000 miles. Three stellar points could be detected in the forward portion of the nucleus, but only two in the other. The separation between the two brightest points was about 10″. The spectrum showed no new developments. To the naked eye the comet was unexpectedly bright, although now distant from both sun and earth nearly 140,000,000 miles. The head looked like a fourth-magnitude star, and the tail was 16° long and 4° wide at the extremity. On November 20th the nucleus had almost vanished, appearing merely as a brighter streak in the structureless nebulosity of the head. The tail was still nearly as large as ever, and easily visible without telescopic aid, though of course much fainter than on the 4th. The comet has held out remarkably, and, so far as now appears, it may be observable for a long time yet, especially in the southern hemisphere.

showing that the principal brilliancy of the comet was not reflected sunlight. The usual carbon bands of the cometary spectrum were not visible through the sky illumination, and no other bright lines except those of sodium were seen by Thollon. On the 22d the comet's spectrum was observed in the early morning just before sunrise by Ricco, of Palermo. He reports his observation thus: "The spectrum was formed of the narrow continuous spectrum of the nucleus, traversed by a large and strong line of sodium (D); by enlarging the slit I saw a globular, monochromatic image of the nucleus and coma. Besides the line of sodium many others were present, but, my spectroscope not having a micrometer, I did not determine them. I observed a band in the red, a line in the yellow near and after D, two others in the green, and an enlargement of the continuous spectrum in the green and blue." It is exceedingly unfortunate that the position of these lines could not have been determined, at least approximately. No one can predict when such an opportunity will occur again.

The weather in this part of the country was abominable up to November. The writer attempted to get spectroscopic observations on September 20th, but was foiled by clouds, and has since succeeded only on October 2d, 4th, 10th, 15th, and 24th. On the first of these dates the sodium-lines were still easily visible, though not conspicuous. The carbon bands were magnificent, especially the brightest one (in the green), in which could be clearly seen the three fine lines observed in the spectrum of Coggia's comet. The band in the violet was very faint. The nucleus gave a strong continuous spectrum, on which the carbon bands were superposed; and in the tail the proportion of white light (continuous spectrum) to carbon light appeared to be about the same as in the nucleus. The bands could be followed far out into the tail by widening the slit, but were lost before the continuous spectrum quite vanished. No dark lines were made out. On the 4th the results were the same, except that the sodium-lines were very hard to see, and they disappeared entirely before the next date. The later observations added nothing more. It is much to be hoped that, when the different results of all observers come to be collected and published, something will be found to supply what is so unfortunately wanting in Ricco's most interesting but incomplete observation—*hiatus valde deflendus.*

The highest interest of the present comet lies in its orbit, however, its relation to preceding comets, and its possible speedy destruction by the sun. Almost as soon as it appeared, Professor Boss in this country and Hind in England proposed the hypothesis that it is identical with the great comet of 1880, the period of the latter comet having been shortened by some resistance. If so, this comet will be back again in a few months, and before long must fall upon the sun. They have weighty arguments on their side, but on the whole a different conclusion is more probable.

On September 17th the comet passed its perihelion at a distance of about 750,000 miles from the sun's center, and within 300,000 of its surface, rushing through the coronal regions with a velocity exceeding 300 miles per *second:* it swept over 180° of its orbit in three hours and a half. Thus far we find in our lists of cometary orbits only four with so small a perihelion distance, viz., the comets of 1668, 1680, 1843, and 1880. (As to the comet of 1668 there is some doubt, because it was only observed for about three weeks, and its motion during that time was such that it answers almost equally well to either of two quite different orbits.) There are half a dozen others with perihelion distances between one and a half and five million miles, viz., comets of 1767, 1816, 1826, 1847, 1865, and 1870; and Wells's comet, which disappeared only a few weeks ago, is just outside that limit, with a perihelion distance of 5,675,000 miles. Now, as to the comets of the first class, we find that, excepting that of 1680, their orbits are extremely similar; their plane and direction of motion are almost exactly the same; the perihelion distances are nearly the same for all; and the axes of the orbits all point to the same part of space; they have all come toward the sun from the same region of the heavens, in the immediate neighborhood of the great star Sirius. In the little table below are given what are called the elements of their orbits: Ω is the longitude of the node, i the inclination of the orbit to the ecliptic, π the longitude of the perihelion, and q the perihelion distance, expressed as a decimal fraction of the earth's distance from the sun; e is the eccentricity of the orbit; and the — in the last line denotes that the motion is retrograde. The orbits of the first two are

	1668.	1843.	1880.	1882.
Ω	357° 17′	361° 12′	356° 17′	345° 50′
i	35° 58′	35° 41′	36° 53′	38° 05′
π	277° 2′	278° 39′	278° 23′	276° 28′
q	0·0047	0·0055	0·0059	0·0076
e	1·0	0·99989	0·99947	0·99997
Direction	—	—	—	—

from the catalogue in Chambers's "Descriptive Astronomy"; that of 1880 is the orbit computed by Meyer, of Geneva, from the whole assemblage of observations, and that of 1882 is the last orbit computed by Mr. Chandler, of Cambridge, and may be found to need some correction when later observations come to hand. Fig. 4 shows in a rough way how these orbits lie in relation to the orbit of the earth, and how very long and narrow the comet's orbit is as compared with the circle described by the earth.

Now, the similarity between these orbits may be explained in two different ways. It might be accounted for by supposing that we have to do with different visits to the sun of a single comet, or that we have here a group or family of comets, very likely of common origin,

but separate, and following each other. Hoek, of Utrecht, showed some years ago that such comet-families exist. When we compare the orbits of the comets of 1843 and 1668 there is nothing that forbids the idea of their identity. The differences are no greater than probable perturbations might account for. Then, again, the comets of

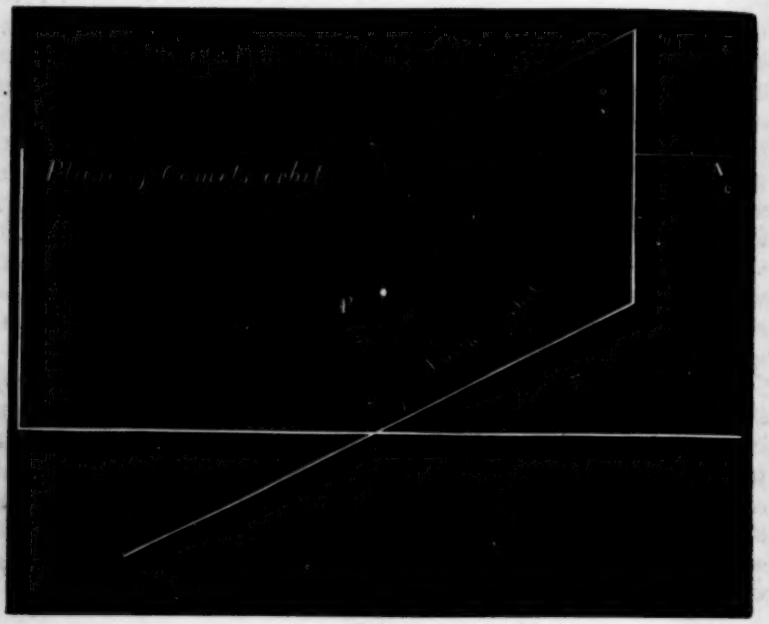


FIG. 4.

1843 and 1880 may easily be identical. Indeed, the orbit given for the latter comet corresponds to a period of almost thirty-seven years, and Meyer has shown that the observations can not be reconciled with a period less than thirty or greater than fifty years. Now, thirty-seven years would take us back just to 1843, so that it is very likely that these two comets are really one and the same. So far the "identifiers" have matters their own way. But, now, as to the comet of 1882. Can it be identical with the comet of 1880? We think not. The orbit of the latter was computed exclusively from observations taken *after* its perihelion passage, so that no action of the *sun* depending upon its close approach at perihelion can account for its return in less than three years, and the inclination of its orbit is such that ever since it went out of sight it has been out of harm's way as to perturbations by the *planets*. Then, again, the orbit of the comet of 1882 does not agree with the idea of identity. Whatever other effects may have been produced by the resistance of the solar atmosphere at perihelion, this resistance must have tended to *shorten* its period, if it changed it at all. Now, the observations thus far taken, though per-

haps not sufficient to settle the orbit definitively, seem to be absolutely inconsistent with a period of anything like three years (corresponding to an eccentricity of 0·9963). The period can not well be less than ten or twelve years, according to the last results, and may be several thousand. It is to be noted, further, that, as regards Ω and q, the two orbits differ more than can well be consistent with the theory of identity. It seems to be an almost necessary consequence that these two comets can not be identical with each other, though they may, perhaps, both be fragments of the comets of 1668 or 1843, or of some comet more ancient than either.

It is an interesting fact that Mr. Chandler finds that his orbit, computed entirely from post-perihelion observations, satisfies almost exactly the observation of Mr. Finlay, taken on September 8th, as well as the observation of the comet's disappearance at the sun's edge. If the observations of Dr. Gould, when they come to hand, agree as well, it will be proof positive that no sensible resistance or disturbance of any kind was suffered by the comet in passing within 300,000 miles of the sun's surface at the rate of 300 miles a second.

Of course, if the view we have taken is correct, there is no possibility that our comet can return in six months and fall into the sun. Not that there is any *absurdity* in the idea by itself considered. If the comet of 1880, when receding from the sun, had moved in an orbit corresponding to a three years' period, and if the present comet were found to have a period of three years or less as it is now receding from the sun, it would be almost impossible to refuse to admit their identity, and probable speedy absorption in the sun.

We close with a single word as to the probable consequences of a comet's fall upon the sun. Unquestionably, the energy of the comet's motion would be transformed into heat, and if the comet had any considerable mass, say $\frac{1}{100}$ the mass of the earth, the heat produced would be enough to supply the sun's heat-expenditure for months. Probably, however, no comet has a mass anything like so great as that; more likely the present comet even, huge as it is, has a mass less than $\frac{1}{100000}$ of the earth's, so that its collision with the sun would produce as much heat only as the sun would expend in eight hours.

Now, if the sun were a cool, solid, or even liquid mass, the sudden accession of merely this quantity of heat would undoubtedly produce an enormous rise of temperature and a great increase of radiation. But, constituted as the sun is—mainly a mass of gas and vapor—the effect would be entirely different, the energy being principally expended in producing expansion and evaporation, with comparatively little increase of temperature or radiation. If one stirs up the fire under an open kettle, the water gets no hotter—it only boils faster. Probably the effect of the fall of a body, even as large as the earth, upon the sun, would be hardly anything more than to restore the sun to the condition it was in a century ago. The energy lost in the course

of a century would be replaced—that is about all. During the few moments while the body was passing through the sun's atmosphere, there might be, and probably would be, phenomena of great interest and beauty to those who were on the watch; but it is very doubtful whether people generally would know anything about the occurrence until they read of it in the papers.

SCIENTIFIC PHILANTHROPY.*

By ALFRED FOUILLEE.

THE questions relating to public relief, population, and natural selection are so inseparable that, in our age, thought has been logically conducted from one to another of them, and has been led to important discoveries. It was the problem of public relief, and the observation of the effects produced by the poor-rates, that inspired Malthus to compose his "Law of Population"; it was the law of population, in turn, that led Darwin to the discovery, first, of the law of the "struggle for existence," and afterward of that of "natural selection." We may say, then (and the fact is worthy of remark), that it was a social and economical problem that provoked one of the greatest revolutions in natural history. Even before Darwin, Mr. Spencer, by studying in his "Social Statics" the influence of philanthropy on the movement of population, upon the artificial multiplication of the feeble in body or mind, and upon the deterioration of the race, had shown how vital competition might produce, by means of selection and elimination, sometimes progress, sometimes decadence, of a species. He thus anticipated Darwin; but he did not perceive, as Darwin did, the capital fact of the divergence from the primitive type which results from natural selection among living beings, and produces the final variation of species. Nevertheless, natural science and social science have shown an intimate connection in this respect, which exists no less in all the other problems. Thus, we are not able from this point to separate these two sciences. To reduce sociology to the category of moral, economical, and political sciences is to condemn it to remain an abstraction, and to treat its problems incompletely by ignoring essential data; the legist, the economist, and the politician, who take no account of the laws of biology, are like a doctor who is not acquainted with the structure or the functions of the organs, or, to use Mr. Spencer's comparison, resemble a blacksmith who would work in iron without knowing anything of its properties. We must, therefore, approve of labors which, like those of Messrs. Spen-

* Translated for "The Popular Science Monthly," from the "Revue des Deux Mondes."

cer, De Candolle, Ribot, Galton, and Jacoby, include the study of the effects of natural selection and physiological or moral heredity in human society. Philanthropy ought not to content itself with reasons of sentiment; it should become scientific. Few questions are better adapted than that of public relief to demonstrate the necessity of this progress and the extreme complexity of social problems, in which the most various rights are involved and the laws of natural history add their force to those of political economy. What, in the Darwinian point of view, becomes of the public duty of relief? First, what is its moral foundation, misconceived by certain partisans of Malthus and Darwin, and what are its necessary limits? Secondly, are there not biological laws that intervene in a question at first sight entirely moral; and can the legislator neglect the social consequences of these natural laws? In short, has philanthropy regulated by science a salutary or an injurious influence on the movement of population, and does it produce in the race a useful or a harmful selection, progress or decay? These are the principal problems deserving a long study, to which we will at least call the attention of readers. If we only show clearly their difficulties, and vaguely forecast the solutions of them, we shall not have wasted time or trouble.

The partisans of Darwin generally adopt in social science the law of Malthus, from which Darwin himself has drawn most important consequences in natural history. Now, Malthus has conceived that by this law he could condemn absolutely that philanthropy which is practiced under the form of public benevolence. He not only denies all duty of relief on the part of the state, but also declares private charity dangerous and irreligious. Leave to Nature, he says, severely, the office of punishing the improvidence of the father who calls to life more children than he can support; Nature will not fail to perform her task, and it is a providential one. Since Nature is charged with governing and punishing, it would be a very foolish and misplaced ambition to pretend to put ourselves in her place, and take upon ourselves all the odium of execution. Then give up that guilty man to the penalty imposed by Nature. The aid and assistance of parishes should be closed against him, and, if private charity extends any help to him, the interest of humanity imperiously requires that that help shall not be too abundant. He must be made to learn that the laws of Nature, that is, the laws of God, have condemned him to a life of pain for having violated them, and that he has no kind of a right as against society to obtain from it the slightest portion of support. Can this summary condemnation of public charity, pronounced by the Malthusians and the radical Darwinians, be accepted from the point of view of morals and right, and must we inevitably maintain it from the point of view of natural history, or even of the laws laid down by Darwin?

Regarding the question of right, it seems to us that a capital distinction should be made between the present and the future, between

the duty of the state toward those who are born and its duty in respect to those who may hereafter be born. There is at this moment upon the earth enough, and more than is needed, to support the men who are now living; but the time may come when there will not be enough to support all those who may have been called to life, and it is only at that time that the Malthusian law of population will become incontestable. The moralist should, then, place himself in succession at both these points of view—points between which neither the Malthusians nor the Darwinians have sufficiently distinguished.

To get a better comprehension of the question, let us begin by examining the simplest cases, after which we will consider the more complex reality. To revive an ancient and classical example, from which we may draw new consequences, let us suppose a man settled by himself on an island, on which there is not only all that he needs, but a superfluity, and that a shipwrecked man is afterward cast upon the island. Undoubtedly the first occupant is not obliged to give up that which is indispensable for his own life, but he owes the new-comer a part of his superfluity. If the island affords sufficient to support two men, the first one has no right to monopolize the whole of it. He ought, then, to surrender to the companion, whom chance has sent him, a part of the soil. By doing this he will perform not only one of the acts of benevolence discredited by the Malthusians and Darwinians, but the act will be one of strict justice. Now, let other men come upon the island; let the soil be wholly occupied, appropriated, covered with houses, and inclosed in fences; and then suppose a new shipwrecked man lands upon it. The island either can or can not support and maintain another man. In the first case, the inhabitants, unless they desire to regard the new-comer as in a state of natural war as to them and their property, must allot him a portion of ground; or, if the ground is already entirely appropriated and divided out among the inhabitants, they owe him such employment as will furnish him the means of subsistence. The obligation is incumbent not upon a particular individual among the inhabitants of the island, but upon all the individuals collectively, and it is the duty of each one to contribute according to his resources to the common obligation. Assistance is thus a guarantee and defense of property, a treaty of peace succeeding the state of war. It ceases to be an act of justice, and begins to be an act of pure charity only when the portion of the new-comers can no longer be afforded them except by depriving the first occupants of something they need. In this case it becomes necessary, in effect, to sacrifice one man to save another.

Suppose now that, instead of being brought to the island by the casualty of a storm, the new-comers have been introduced upon it by the voluntary action of particular persons; the right of these new-comers to assistance will subsist for the present, but it is clear that the mass of the inhabitants will have a right to watch over such intro-

ductions in the future and regulate the conditions under which they may be made. If the question, for example, is one of bringing children into the world in greater numbers than the island can support, the little state we are considering will not be able to assume the duty of future assistance unless the individuals on their part renounce, as John Stuart Mill has it, their right of indefinite multiplication.

It is through failure to make the preceding distinction that Malthus rejects the whole obligation of assistance, and leaves it to Nature to do justice. The penalty attached to improvidence by the laws of Nature, he asserts, falls immediately upon the guilty one, and that penalty is itself severe. But, we may ask, are not those who suffer from the improvidence of the father, contrary to this assertion, the innocent wife and children? Let them alone, Malthus persists; let God's justice take its course. These pretended laws of God, of which Malthus tries to show us the justice, are injustice itself. The English pastor had no other resource for escaping the objections of the moralists than to invoke original sin. "It appears indispensable," he says, "in the moral government of this universe, that the sins of the fathers shall be punished in the children. And if our presumptuous vanity flatters itself that it could govern better by systematically contradicting this law, I am led to believe that it will engage in a vain enterprise." Where Malthus sees an effort of human vanity, social science sees an effort of human justice, superior to the pretended justice of Nature or of Providence. To trust to natural and providential laws for the prevention or reparation of wrong is to act like beings without intelligence or will—is to accept for man the fatality that controls animals, "which, however, have not eaten of the forbidden fruit."

The argument of Malthus, adopted by many English economists, as well as by the naturalists of the Darwinian school, is contrary, not only to pure fraternity, but also to strict justice. Malthus reasons as if there were at this very time not enough food on the earth for all the men; as if in the existing state of society there were to be found no men enjoying superfluity, while there are, however, men who have nothing to live upon. Instead of limiting his assertions to the future, and to a future still far off, he speaks as if those harsh words which have been so many times cast in reproach by the socialists against the strict economists, as containing the most authentic formula of their theories, were applicable even to the present time: "A man born into a world already occupied, whose family has no means of supporting him or of whose labor society has no need, has not any right to demand any portion whatever of food. He is really one too many on the land. No cover is laid for him at the great banquet of Nature. Nature tells him to go away, and does not delay herself to put the order into execution." All is involved in that doctrine; it is in effect the right even of living that Malthus denies to a host of men. To solve the question he has recourse to Nature, which knows neither pity nor justice; he

should, on the contrary, have appealed to the reason and freedom of man. In fact, it is not only at the "banquet of Nature," as Malthus asserts, that the new-comers demand a place, it is more, and above all at the banquet of humanity; they are men, and men have called them into existence: did any one consult them before giving them the light? And if their parents have brought them to life without their consent, is it not on the implied condition that they will furnish them a share of subsistence in exchange for a share of work? When a child is born into a family, it is rightly said, none of his brothers has the right to prevent his sharing in the property of their father; likewise, there are no "cadets" in a nation. If the family fails, there is still above it the great national family; a solidarity exists between all the citizens of the same country. It is by reason of this that you, legislators, unable to establish a law to regulate the multiplication of the species, have implicitly accepted certain charges in regard to the children who are born, in the event of the failure of their natural fathers and mothers. Such children are neither "usurpers" nor "intruders," for they are not themselves responsible for their birth, and you have no right to say whether you will accept or reject them, for there is actually enough of subsistence for all. The Darwinians will presently show us the necessity of society taking precautions for the future, but the present charge, nevertheless, exists, and we must execute it. In the existing society the capital is not lacking, but all the men have not their share; this state of affairs, the inevitable effect of economical laws, creates in the laborers a condition of inferiority and servitude. Here, then, is a place for the intervention of reparative justice in the form of public assistance. Is the man who, in the midst of a dearth, refuses to sell his corn, or who buys a large quantity of corn to take it out of the market, exercising his right? He might, perhaps, claim that he was the legitimate proprietor of the product of his fields or of his purchases. But the identical principle on which property is founded —that is, the right to work for a living—limits it by the equal right of another. Society has not hesitated to impose restrictions and obligations as to many points on proprietors who assume to be "absolute"; it prevents them from blocking the course of circulation; it expropriates for causes of public use; it punishes the man who burns his goods; it can exact an indemnity from the one who lets his property go to waste. As a rule, no right relative to exterior objects can be absolute; there is always a place for reciprocal limitations, and consequently for conventions and compromises. Respect for already existing properties, and for the established order, can not, in strict right, be exacted from the new-comer unless some means of existence are reserved for him. Here is a relation of contract, a tacit convention: I agree to respect your means of living, on condition that you respect mine; I consent to respect your right to live, on condition that I do not see mine destroyed. There is then a stipulative relation which

establishes at the same time the foundation and the limit of the right of property, on the one side, and of the right to live on the other. The first is not more absolute than the second, but we can not ignore the one without injuring the other.

We can not, however, from the fact that the philanthropic duty of assistance may not be unlimited and unconditional, conclude with Malthus and the naturalists of his school that the duty does not exist. If such a conclusion were logical, we should have to apply it to all real rights, for there is not one of them that is absolute and without limits; not the right of property any more than the others. The only legitimate conclusion is, that it is necessary to confine assistance within certain boundaries, to restrict it by the consideration of other rights, to submit it to conditions, and consequently to make it the object of a contract, and thus to realize on this point as on all the others the ideal of stipulative justice. The practical limitation of a right is always by another right: the right of property, for example, is limited by the right of circulation, by that of condemning it for public uses, etc., and *vice versa;* and the means of fixing the limit is free parleying between the parties, resulting in a contract. All legislation which neglects to give a form of contract to the laws it promulgates, prepares conflicts of every kind for society, and leaves a germ of war in the law itself.

But, while true philanthropy, which has to do only with social justice, ought to consider the present and the past, it has also to deal with the future. It is in this point of view that the theories of Malthus and Darwin gain the advantage; here moral and juridical considerations are complemented by considerations borrowed from natural history. We have already recognized, with Malthus and Stuart Mill, that we can not put this point aside unless we would produce artificially, in a more or less distant future, an excessive multiplication of the species. It now remains to examine, with Mr. Spencer and Mr. Darwin, another rock in the way of the philanthropist—the danger of producing a physical and intellectual deterioration of the species by overlooking the laws of natural selection and heredity.

Philanthropy, apart from science, sees only the immediate influence of the measures it proposes; it entirely neglects their influence, infinitely more important, on the physical status and the morals of future generations. It forgets that every new measure in legislation or policy tends to produce modifications, for better or worse, in human nature.* These modifications are the inevitable effect of biological laws,

* Religious fanaticism, for instance, by its measures of persecution, has produced effects which its partisans were far from foreseeing, and a kind of cross-action. "By a course of penalties and poisonings," says Galton, in his "Hereditary Genius," "the Spanish nation has been deprived of free-thinkers and drained, as it were, of a thousand persons a year, during the three centuries between 1474 and 1784; for an average of one hundred persons were executed and an average of nine hundred persons imprisoned every year during that period. During the three centuries, 32,000 persons were burned, 17,000 burned in effigy (the most of the persons themselves died in prison, or left Spain), and

that is, of the struggle for existence, heredity, and natural selection. A benevolence that takes no account of those laws may become malign, and the short-sighted fraternity that considers only the existing generation may be transformed, as we shall see, into a veritable injustice toward future generations. The great danger to which a blind charity, dissociated from science and stipulative justice, exposes itself is that of depressing the physical and moral level of the race. What are the conclusions of Darwinism on this point? We may, with Mr. Spencer, summarize them in the two propositions which every philanthropist, in his opinion, should have always present in his mind: "The quality of a society is physically lowered by the artificial preservation of its feeblest members; the quality of a society is lowered morally and intellectually by the artificial preservation of those who are least able to take care of themselves." Let us successively consider, and endeavor to restrict to their real bearing, these two capital propositions. The law of Malthus, from which Darwin has deduced the law of the struggle for existence, tends to produce in the existing state of society a numerical surplus of individuals who struggle for life itself. Excessive fecundity has good and bad results. All individuals finding themselves subjected by its operation to an increasing difficulty in gaining their living, there is produced in society a kind of pressure, the natural effect of which is, on the average, a progress. Those alone, in effect, can survive who are capable of resisting that pressure, and even of advancing under its influence; these, then, may be considered "the elect of their generation." When an individual succumbs, it is always for lack of power to triumph over some action of the environment—cold, heat, moisture, insalubrity of air, etc. He can not make way against one or many of the numerous forces that act upon him, and in the presence of which his vital activity is called upon to display itself. He may succumb to them more or less quickly, according to the vigor of his organization and the incidents of his career; but, in the natural course of events, those who are imperfectly organized pass away before having any offspring, and only the most vigorous organizations contribute to the production of the succeeding generation. Such is the natural selection, favorable to the improvement of the species, which is produced in mankind when Nature is allowed to act without contradiction. It is, says Mr. Spencer, a natural work of elimination by which society is continually purifying itself. Suppose now that a

291,000 were condemned to prison and other penalties. It is impossible for a nation to endure such a policy without suffering a great deterioration of the race. The taking from the nation its most intelligent and most vigorous men had for its most noteworthy result the formation of the unintelligent and superstitious race of contemporary Spaniards." Attention has frequently been called to the disastrous effect of the military *régime* of our epoch, which deprives the family and labor of the soundest part of youth, and, leaving at home only the weak or sickly men, produces a selection backward in the nation. When war is added to universal armament, it harvests the best part of a people, and debases the generations which follow it.

philanthropy ignorant of social science and of the natural sciences undertakes to correct Nature, to diminish at any price the chances of mortality of the weak, to cause them by means of its care and its assistance to survive artificially, what will be the results for future generations? At first, population will increase more than it would have done; every one will then find himself subjected to a greater difficulty in living, and exposed to destructive actions of the most intense character. This increase of population might still produce good results if it were not due to an increase in the number of the weak. But the survival of the weak spoils all; they marry with the strong, who under other conditions would alone have survived; such marriages change the general constitution of the race, and cause it to come down to a lesser degree of force, and what we might call tonicity, corresponding with the conditions of existence that have been artificially created. Such an instrument, whose cords are relaxed, no longer gives to strong or harmonious sounds as of old. An effeminacy of the species is produced, and it has become at the same time a little more numerous and a little weaker. In preserving the less vitalized part of the present generation, we have prepared for the decadence of coming generations.

This decadence is brought about also by other causes. Your philanthropy, say the Darwinians, suppresses or attenuates some noxious influences, and this gives delicate constitutions more chances of surviving and propagating themselves; but you do not perceive that, in place of the unfavorable influences suppressed by you, you cause new destructive ones to arise. "Let the average vitality," says Mr. Spencer, "be diminished by more effectively guarding the weak against adverse conditions, and inevitably there come fresh diseases," for the increase of diseases is the correlative of diminished vitality. Look at the numerous diseases unknown among barbarians from which civilized races suffer. Diseases of the brain, especially, seem to increase with civilization; the proportion of them to the whole population appears to have doubled in France since 1836. The activity which is stamped upon industry, the arts and the sciences, political and social agitation, the fever of money-making, and the consuming life of cities are engendering in civilized nations a condition of cerebral agitation resembling intoxication, which must predispose to intellectual troubles. We may add that the necessity of supporting the weak and non-producers, as Mr. Spencer says, imposes an additional excess of burden on the producers; the weariness of the latter increases till it becomes a cause of sickness and premature death, and the mortality which has been evaded in one shape must come round in another; and, finally, it is the inferiorly endowed who survive and the best endowed who perish. If this misguided fraternity is perpetuated, it will end, according to the Darwinians, by changing a vigorous and youthful society into a prematurely aged society. Suppose a whole nation composed of old

men: old age differs from youth and the age of maturity in being less active in production and less capable of resistance to destructive influences; men feeble in constitution, while they are still young, are in an analogous position. A society of enfeebled persons would, then, lead the kind of life that a society composed of old men, with no one to wait upon them, would lead. The resemblance becomes complete in the fact that in both groups life lacks the energy that renders labor easy and pleasure keen. The old man sees the causes that give him suffering increase and those that give him pleasure diminish, for physical exercise is the condition and the accompaniment of most pleasures. Thus is produced a languishing, monotonous, and dreary life. Finally, says Mr. Spencer, when the average type of the constitutions among any people has fallen to a certain level of vigor inferior to that which can without difficulty resist the ordinary strains, and perturbations, and dangers, mortality is still not diminished, and, on the other hand, life, ceasing to be an enjoyment, becomes a burden.

Such are the views of the Darwinians upon the physical deterioration of races by the operation of a mistaken philanthropy. These considerations show well that moralists, economists, legislators, and statesmen ought to come out from the traditional routine to study, in the light of the laws of contemporary biology and sociology, what will be the effects in the future of the measures they recommend or adopt. Nevertheless, we should beware of exaggerating the bearing and consequences of the theorem we have just postulated. There are distinctions to be made, and those who share the views of Darwin do not always make them. Let us first leave out of the account the really sick, who are taken care of at home, or in the hospitals. Diseases are, as a rule, generally accidental, except when they result from an original constitutional defect or from some willful excess. Evidently we are not rendering a bad service to society when we take care of workmen who have been afflicted with sickness or are the victims of some accident. Suppose the wife of a vigorous and efficient workman falls sick; if the workman is very poor and no one comes to his assistance, he will be obliged to overtax and exhaust himself to take care of her; and that would be a loss to the whole community. His children, of good constitutions, who would have lived if the mother had been assisted, will become ill or die if the family is reduced to want. Is it necessary to let those whom disease attacks die without pity, as armies are sometimes forced to abandon those who fall on the road? No Darwinian will in good faith maintain that. The theorem of Darwin can apply, then, only to the infirm properly so called, to whom philanthropy is accustomed to give assistance, as well as to men attacked with accidental diseases. We may, however, here first call attention to the fact that the infirm inmates of hospitals and those who are succored at home are a small part of the nation; and it is no great inconvenience to the sound to take care of them. Moreover, the

infirm in the hospitals hardly ever contract marriage; so that we need not fear much from their posterity. Furthermore, we might, if it should become necessary, impose conditions and even legal restraints upon their marriage. The same is the case with the infirm who are assisted at home; if they have any important physical infirmity, they seldom think of marrying, and are hardly ever able to marry. The Darwinian theorem, moreover, proves too much, for it is applicable not only to the weak in body, whom philanthropy takes under its protection; to be logically carried out, it should be taken home to each family, and insist that no deformed or weakly child deserves to live. We should say no more, "Woe to the conquered!" but "Woe to the weak!" In effect, when a father and mother preserve the life of their child only by the exercise of the greatest care, when a doctor employs all his skill upon it, that fatherly and motherly care, that medical skill, will only have succeeded in preparing "artificially for society a member without vigor"; and the latter, in his turn, by marrying, will put into the world children still less vigorous. The Spartan method of disposing of feeble children will then become that of the perfected sociology. We shall test men as we now test our guns, throwing away those which can not support a certain pressure. The struggle of art against the natural elimination of the least vigorous is carried on in the bosom of the family rather than in the hospitals. Public philanthropy does not, therefore, appear to be responsible for the principal inconveniences it brings; it is parental love that we have to deal with, and, since that love is infinitely more advantageous than inconvenient to society, it is our duty to brighten, not to obscure it.

It is rather before marriage than after the birth of children that the real problem presents itself, and philanthropy should be exercised in the interest of humanity itself. There is a moral question here, and it is for the moralist to instruct the weak, delicate, or sickly person, concerning the grave responsibility he assumes in contracting marriage and running the danger of entailing upon his children the evils from which he is suffering. Man, says Darwin, scans with scrupulous care the character and pedigree of his horses, his cattle, and his dogs before matching them, but never takes such a precaution when the question is one of his own marriage. It is certain that the person who calls another being into life is not the only one concerned in the matter, and that, if he has a good supply of physical evils in himself, he ought to hesitate before condemning his posterity to them. But must we go further, and make a social and judicial question of the moral one? Ought the state, the natural protector of the rights of third parties, to intervene here in the physical interest of the children and of the nation, as it interferes for their moral interests and even in questions of mere future? Darwin and his partisans, M. Ribot, for instance, are inclined to have the state intervene now, or as soon as custom shall have prepared the way for its intervention. When, says

Darwin, we shall have come to a better comprehension of biological principles, of the laws of reproduction and heredity, for example, we shall no longer hear ignorant legislators repelling with scorn a plan for ascertaining whether or not consanguineous marriages are injurious to the species. According to Darwin, persons of both sexes should be prohibited from marrying when they are found to be in too marked a degree inferior in body or mind. The same rule would apply to those who will not be able to save their children from abject poverty; for poverty is not only a great evil in itself, it also tends to grow by promoting indifference in marriage. M. Ribot expresses the just hope that custom will eventually take account of the data of science in this grave question, but he also contemplates the ultimate intervention of the law. This is, in our view, a dangerous means. In aspiring to favor well-assorted marriages in a physical respect, the law would, in the first place, favor licentiousness and the birth of illegitimate children. Now, licentiousness and the temporary union of the sexes unaccompanied by forethought and determined responsibilities, would encumber society with good-for-nothings to a much greater extent than the marriage of weakly beings. In the second place, the intervention of the law might impose hindrances, to a much greater extent than that of parents, to morally and intellectually well-assorted marriages as well as to congenial ones. Finally, governments are still less infallible than parents in the matter of making a decision concerning the future of children. All that could be done would be to exact from those wishing to marry some assurance that they have the means of living, and will be able to take care of their children. It would still be necessary, we repeat, to prevent such a policy operating, as it does in Germany, as a promoter of illegitimate births. This question is not, however, in reality, within the province of philanthropy properly so called, with which we are particularly occupied. Philanthropy can be charged here only with the assistance which it gives the feeble-bodied for the prolongation of their existence, and for the means it affords them for bringing into the world still feebler children. The Darwinians exaggerate the harm caused by philanthropy in this respect; for they forget that it can not wholly transform nature. Its power is limited to prolonging the life of an individual (which is no great harm), or to prolonging his race for a time that is more or less brief. One of two things must be the case: either the evil relieved by philanthropy is a fatal germ of decay and death for the posterity of the assisted man, in which event the benevolence will only delay without preventing the inevitable extinction of that posterity; or, on the contrary, the evil is reparable and posterity may recruit, strengthen, and perfect itself—that is, may cross over the mountain instead of falling back upon it. Must we in the latter case reproach Philanthropy for having held out the hand of relief to those who were about to fall for ever? This dilemma can be resolved only in each particular instance as it occurs; what right

have we, then, to prejudge the solution, and that in favor of the cruelest sentiments? We shall shortly see that the inconveniences, when they exist, are compensated by the advantages. The logical conclusion is that, if the moralist ought not to be too much occupied with these complex problems, so the legislator can not be too prudent when he is thinking about intervening, for his intervention will be much more artificial, and may be more dangerous, than the intervention of philanthropy.*

Let us now pass from the influence which philanthropy can exercise directly upon individuals to that which it can exercise upon the environment, by making it more favorable to the weak and wretched. There is here an important distinction which the Darwinians too often neglect to make. Among the conditions of the environment, of hygiene and of health, which can be managed for the whole of a population, we should designate first the normal conditions which tend to assure the normal development or performance of the organs, such as pure air, nutritious and sufficient food, proper clothing, healthy houses, the adjustment of the work to the strength, etc. A philanthropy which endeavors to realize these conditions for the largest possible number of men is evidently acting in the same direction with nature; far from enfeebling the generations, it is fortifying them. It would be a sophism to assume that we could fortify the generations any better by habituating them to do without these favorable conditions, for we can not do without necessaries; the budget of nature and life is fixed, and can not be varied except within narrow limits. What would we say of a father who, to exercise the nutritive functions of his children, should try to habituate them to living without eating, who to exercise their lungs should place them in a vitiated atmosphere, who to exercise their sense of sight should make them work and read in an unlighted room? That would be to propose a problem as insoluble as that of making a fish live without water. In fact, populations subjected to unhealthy influences become wretched and sickly; their children fail to grow; they are thin-blooded, feeble, small, thin, and tainted with such diseases as goitre, pellagra, ophthalmia, and cretinism. We can not add to the strength of men by making them live in unhealthy districts instead of healthy ones. Excessive labor likewise exhausts the minds and bodies of generations as it does of individuals. Doubtless the strongest will survive, but they will survive enfeebled, and, although relatively strong, they will have really

* The fact is furthermore established by statistics that, notwithstanding the increased propagation of the weak in civilized societies under the influence of philanthropic feelings, and notwithstanding the increase of population, the length of life is now greater than formerly. This proves that the decrease of some causes of mortality has been greater down to the present time than the increase of other causes. Furthermore, the debility of the existing generations may be a result of the stimulus which has been given to industry under conditions which are still very defective, and which will be improved in the future.

become weak; they are the one-eyed among the blind. We shall thus have obtained a survival of the weak, who will beget weak offspring. The argument of the Darwinians may then be turned back upon them, and we may propose on our side the following theorem: To realize the normal conditions most favorable to mankind is to assume the development and selection of a majority of the strong while saving only a minority of the weak; for to be sick is the exception when the conditions as to hygiene and food are at the best.

The reasoning of Mr. Spencer, repeated by M. de Candolle, is, in our view, valid only under abnormal conditions. If we bring up children effeminately, in mental and physical idleness, if we feed them on candies instead of bread and meat, if we keep them in a greenhouse and out of the open air, if we do not let them take any exercise for fear they will be tired, we shall evidently debase them, and prepare, through them, for the debasement of the race itself. In short, the causes for the deterioration of a generation are luxury, effeminacy, and idleness. There is nothing strange from this point of view in Dr. Jacoby's demonstration, that extinction is the ultimate fate awaiting every royal and aristocratic family, that it has come or will come upon the Cæsars, the Medicis, the Valois, the Bourbons, our French nobility, the Venetian aristocracy, and the English lords; for it is in such families that the causes of decay, inseparable from power and riches, produce their fatal results. Sterility, mental disorders, premature death, and the ultimate extinction of the race, do not constitute a future reserved particularly and exclusively for sovereign dynasties; all the privileged classes, all families occupying exclusively elevated positions, share the lot of reigning families, although to a lesser degree, which degree is always in proportion to the grandeur of their privileges and the altitude of their social state. But if we grant this principle for once, we may still ask the pessimist disciples of Darwin if philanthropy is in the habit of assuring to the needy the luxury and the soft life of aristocracies. It at least, one may say, permits idleness; but that is the fault of those who come to the assistance of the suffering workingmen, for it is their right and duty to require an equivalent in labor for the assistance they give.

We have as yet examined only the first of the Darwinian theorems relative to the effects of misapplied philanthropy: a society may deteriorate in a physical respect by the artificial preservation of the weakest, if it does not conform to the real course of nature. The Darwinians add to this that it will also deteriorate in a moral respect, by the artificial preservation of the individuals "least capable of taking care of themselves." The principle on which this new theorem is based is that the laws of heredity and selection are applicable to the moral as well as to the physical side. We admit that Messrs. Galton, Ribot, and Jacoby have undoubtedly established this principle. Moral

vices, like physical vices, end, after they have been for a long time implanted in families or races, by transmitting themselves from generation to generation. Darwin insists much on the transmission of that moral quality which he calls character, strength of will, courage, self-reliance; on the other hand, there are also, according to him, people trifling, idle, and careless by right of birth, like the Irish. Transport to the same country an equal number of Scotch and Irish, says Darwin: at the end of a certain time the Irish will have become ten times as numerous as the Scotch, but the latter, by virtue of their hereditary qualities, will be at the head and occupying the highest places. "If any one denies," says Mr. Spencer, "that children bear likenesses to their progenitors in character and capacity, if he holds that men whose parents and grandparents were habitual criminals, have tendencies as good as those of men whose parents and grandparents were industrious and upright, he may consistently hold that it matters not from what families in a society the successive generations descend. He may think it just as well if the most active, and capable, and prudent, and conscientious people die without issue; while many children are left by the reckless and dishonest. But whoever does not espouse so insane a proposition, must admit that social arrangements which retard the multiplication of the mentally-best, and facilitate the multiplication of the mentally-worst, must be extremely injurious." Help the least meritorious to propagate themselves by enfranchising them from the mortality to which their absence of merit devotes them, and merit itself will become more and more rare from generation to generation. Furthermore, besides seeing to their own preservation and that of their families, the good will be obliged also to look to the preservation of the bad and their families, and will be thus in danger of being overtaxed. This is what Stuart Mill also complains of. In consequence of the unintelligent use of the income-tax, and the obligation of every parish to support its poor, the workers are compelled to take care of the idle. Is this justice? In some cases, this situation prevents the industrious from marrying; in others, it limits the number of their children, or prevents their giving them a sufficient support; in others, it takes industrious men from their families; in every way it tends to arrest the propagation of the capable, to injure their constitution, and to bring them down to the level of the incapable. During this time the latter will increase and multiply, conformably to the misinterpreted wisdom of the Bible; they will swarm at the expense of others. This, says Mr. Spencer, is a deliberate storing-up of miseries for future generations. We can not make a worse present to posterity than to encumber it with a continually increasing number of imbeciles and criminals. To aid the bad in multiplying is, in effect, the same as maliciously providing for our descendants a multitude of enemies. We have a right to ask if the maudlin philanthropy which thinks only of ameliorating the evils of the moment and persists in

overlooking indirect mischiefs does not produce a greater total of misery than extreme selfishness?

Such are the objections of Mr. Spencer and Mr. Darwin in all their force. In our opinion, they still bear against the blind and irrational exercise of philanthropy, rather than against philanthropy itself. Pushed too far, the theorem relative to the moral and intellectual debasement of societies would have consequences still more inadmissible than that relative to their physical debasement. In fact, the law of mental and moral heredity, which is their principle, is much more vague and loose than the law of physical heredity. What is the meaning of the unprecise expression, "a society lowered by the artificial preservation of the individuals least capable of taking care of themselves"? Does Mr. Spencer mean that parents in the habit, for example, of soliciting at the charitable institutions will beget children endowed with the innate disposition to go to the same institutions? England certainly offers a spectacle of this kind of poor, who are assisted from father to son by the parishes; they are, we might say, the lords of beggardom; in them hereditary indigence is raised to the dignity of an institution. Poor mothers surround themselves with their numerous children as so many titles to assistance—they are Cornelias of a new race. But whose fault is it? Is it not that of the distributors of the poor-taxes, which are, moreover, increasing every day under this system? Is it not, furthermore, the fault of the bad education received by the children, rather than of heredity of temperament? If these children were brought up with the children of a lord, would they exhibit an innate propensity to beg or to be assisted by others? We believe, generally, that Messrs. Spencer and Darwin, as well as Messrs. Jacoby and Ribot, attribute too great a part to heredity, too little a one to education and circumstances.

The part played by the social and political organization in England must, moreover, not be forgotten. In France, by the operation of the rule of equality, there are between four and five million proprietors, and the increase of population is so slow as to give uneasiness to those who regard the material and military power of a nation before everything else. In England, the soil is owned by thirty thousand persons, and half of it is in the hands of a hundred and fifty large proprietors. In consequence of this feudal monopoly and this rule of inequality (for which many of our contemporary writers utter Platonic regrets), neither the workmen nor the villagers can live without the aid of the poor-taxes. The lords having arrogated to themselves the monopoly of wealth, a part of the nation would be reduced to the most extreme wretchedness if they did not deign to compensate for their injustice with their charity. We must admit that they come within a certain distance of reaching this point, for the number of assisted has diminished one half during the last thirty years. In the greater part of England the wages of the agricultural laborer vary between six and

twelve shillings a week; his lodging costs him one shilling a week; it is impossible for him to live on the remainder of his wages with a wife and only two children. Now, by the zeal of biblical preachers, and the traditional improvidence of the fathers, they have on the average eight children, sometimes fourteen or sixteen. The result is that they can not dispense with assistance, either public or private. Not a day-laborer in the field, says Mrs. Grote, lives or supports his family with his wages alone; he subsists partly upon his savings and partly on alms. Having no hope of becoming a proprietor, like the French peasant, the English rustic is prodigal and exacting in the matter of the comfortable; and, as his fecundity realizes the ideal of the Old Testament, his improvidence realizes that of the New. The fecundity and improvidence of the workmen in the factories are still greater.

Gold may be thrown out by the handful in vain; it is impossible to fill this sort of a cask of the Danaïdes; pure charity, while it may relieve the suffering, is incompetent to suppress the causes of misery and supply justice. Neither can religion replace science. There is one thing, says Mr. Spencer, which calls for especially severe reprobation; it is the waste of money inspired by a false interpretation of the well-known maxim, "Charity covers a multitude of sins." "For in the many whom this interpretation leads to believe that by large donations they can compound for evil deeds, we may trace an element of positive baseness—an effort to get a good place in another world, no matter at what injury to fellow-creatures."

But, we ask, does Mr. Spencer see where the evil and the remedy really are when he attributes the carelessness and the idleness of the poor to heredity, and is especially concerned to prevent the transmission of these vices by the blood to future generations? The best processes of Darwinian selection would be without important results in the absence of good education, and education would itself have little power in the absence of just laws. These two essential elements which the Darwinians have overlooked—education and laws—must, then, be reinstated in the problem.

[*To be continued.*]

TRACES OF A PRE-INDIAN PEOPLE.

By CHARLES C. ABBOTT, M. D.

BY the cautious archæologist all evidences of ancient man in Eastern North America—exclusive of true palæolithic implements—are wisely referred to those Indian tribes that, to within a comparatively recent period, were the sole occupants of the territory named. Perhaps, however, the time has come when it may be asked if all the

traces of prehistoric man, gathered along our northern Atlantic seaboard, are of one origin. In other words, have traces of a people later than American palæolithic man, and earlier than the Indian, been discovered?

When we chance upon a stone arrow-point lying in the soil, it is a very different object to the archæologist than the same specimen would be lying in a cabinet. In the latter case, it is an example of man's primitive handiwork merely; in the former, it is not only the production of a skilled worker in flint, but evidence that on the spot where found man once tarried, if he did not dwell there, and that for him a necessity for weapons existed. Further, if but a single specimen be found, we may conclude that it is the point of some arrow vainly shot, or the head of a lance that has been broken and lost. But if, on the other hand, instead of one, we find a hundred scattered over a few square rods of ground, then we have evidence not simply that arrow and spear heads may be of various shapes and sizes, but that where they occur was once a village, it may be, or a battle has been fought at this point, or possibly that here an arrow-maker once plied his calling, the more definite decision being reached whether we find pottery and domestic implements also, or weapons only, or mingled with a multitude of the flakes of such mineral as that of which the weapons are made. Thus it will be seen that the practical results of an archæologist's labors are to be derived from field-work only, not from simple closet studies. He must seek out these hidden village sites, dig in their weed-grown corn-fields, and invade their cemeteries, if he would learn where they lived, where and how they toiled, and finally where and in what manner they were laid to rest.

Of a series of nearly twenty-five thousand implements and weapons of stone gathered from one limited locality by the writer, more than four fifths have been placed together in a public museum. In looking at them collectively, perhaps the most noticeable feature is that of the marked difference in finish and material. Of the chipped objects, such as arrow-heads, one instinctively separates them into finely wrought objects of jasper and quartz, and ruder specimens made of a slate-like rock.

The question is simply, Has this feature any ethnological significance? It is the purpose of this essay to determine this.

The bare fact that one arrow-head is roughly fashioned and another beautifully wrought has no significance beyond the fact that there were skillful and clumsy workmen in every tribe—professionals and amateurs. On a closer examination a fact becomes apparent, however, that should be critically regarded, and this is that the rudely made objects are almost wholly made of the same mineral, while the finely finished objects are of one of three closely allied minerals. The exceptions are too few to have any bearing on the question. Chipped implements of Indian origin, such as occur in every nook and corner

of the Atlantic coast States, are made of flint in some one of its many forms, as jasper, chert, chalcedony, agate, horn-stone, or they are of quartz. I do not deny that they are also of other materials, but that more than ninety-nine hundredths are of this material—flint. In the valley of the Delaware River there are found, also, enormous numbers of similar objects, of quite uniform pattern and rudely finished, made of a mineral characteristic of the locality—argillite. This term, "argillite," as employed by Professor M. E. Wadsworth, of Cambridge, Massachusetts, to whom specimens of implements were submitted for examination, is used to designate all argillaceous rocks in which the argillaceous material is the predominant characteristic; slate, or clay-slate, clay-stone, etc., are simply varieties of it, the term "slate" being only rightfully used when slaty cleavage is developed. The argillite out of which these specimens were made has no trace of cleavage.

The question may now very pertinently be asked, Why may not the Indians have used both minerals, flint and argillite, the one as frequently as the other?

There are no reasons why, indeed, they might not have done so; but, on the other hand, evidences that they did not are not wanting, if the circumstances under which the objects are found have been rightly interpreted.

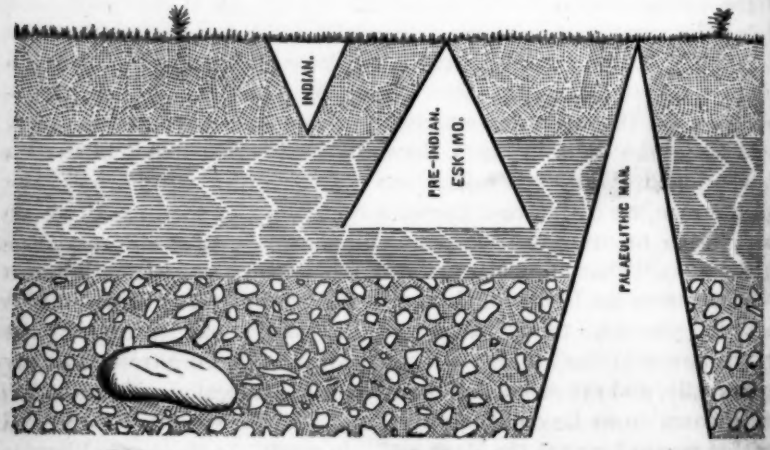
The celebrated Swedish naturalist, Peter Kahn, traveled throughout Central and Southern New Jersey in 1748–'50, and in his description of the country remarks:* "We find great woods here, but, when the trees in them have stood a hundred and fifty or a hundred and eighty years, they are either rotting within, or losing their crown, or their wood becomes quite soft, or their roots are no longer able to draw in sufficient nourishment, or they die from some other cause. Therefore when storms blow, which sometimes happens here, the trees are broke off either just above the root or in the middle or at the summit. Several trees are likewise torn out with their roots by the power of the winds. . . . In this manner the old trees die away continually, and are succeeded by a younger generation. Those which are thrown down lie on the ground and putrefy, sooner or later, and by that means increase *the black soil*, into which the leaves are likewise finally changed, which drop abundantly in autumn, are blown about by the winds for some time, but are heaped up and lie on both sides of the trees which are fallen down. It requires several years before a tree is entirely reduced to dust."

This quotation from Kahn has a direct bearing on that which follows. It is clear how, to a great extent, the surface-soil was formed during the occupancy of the country by the Indians. The entire area of the State was covered with a dense forest, which, century after century, was increasing the *black soil* to which Kahn refers. If, now,

* "Travels into North America," by Peter Kahn (English translation), London, 1771, vol. ii, p. 18.

an opportunity offers to examine a section of virgin soil and underlying strata, as occasionally happens on the bluffs facing the river, the limit in depth of this black soil may be approximately determined. Microscopical examination of it enables one to determine the depth more accurately.

An average, derived from several such sections, leads me to infer that the depth is not over one foot, and the proportion of vegetable matter increases as the surface is approached. Of this depth of superficial soil probably not over one half has been derived from decomposition of vegetable growths. Indeed, experiment would indicate that the rotting of tree-roots yields no appreciable amount of matter. While no positive data are determinable in this matter, beyond the naked fact that rotting trees increase the bulk of top-soil, one archæological fact we do derive, which is, that the *flint implements* known as Indian relics belong to this superficial or "black soil," as Kahn terms it. Abundantly are they found near the surface; more sparingly the deeper we go; while below the base of this deposit of soil, at an average depth of about two feet, the *argillite* implements occur in greatest abundance. The accompanying diagram more clearly sets



forth the conclusions at which I have arrived, after years of careful study of this subject. By this it will be seen that, as the depth *increases*, the number of ordinary flint implements of Indian origin *decreases;* and that the reverse is true of the palæolithic implements which are a feature of the gravel-beds; and is true of that intermediate form which is characteristic of the stratum of sand capping the gravels and blending insensibly with the surface-soil. This intermediate form, which is always made of argillite, is both in workanmship and design a marked advance over the palæolithic implements, and yet is so uniform in pattern and so inferior in finish, when compared with the average flint implement of the Indian, that it has

been assigned to an earlier date than the latter, and considered the handiwork rather of the descendants of palæolithic man.

What is held to be convincing evidence of this has already been given in the statement of the relative positions of the two forms—Indian and pre-Indian—as seen in sections of undisturbed or virgin soil.

Negative evidence of the soundness of this view is had in the character of the sites of arrow-makers' open-air workshops, or those spots whereon the professional chipper of flint pursued his calling.

In the locality where the writer has pursued his studies several such sites have been discovered and carefully examined.* In no one of these workshop sites has there been found any trace of argillite mingled with the flint-chips that form the characteristic feature of such spots. On the other hand, no similar sites have been discovered, to my knowledge, where argillite was used exclusively. The absence of this mineral can not be explained on the ground that it was difficult to procure, for such is not the case. It constitutes, in fact, a large percentage of the pebbles and bowlders of the drift, from which the Indians gathered their jasper and quartz pebbles for working into implements and weapons.

If the absence of argillite from such heaps of selected stones is explained by the assertion that the Indians had recognized the superiority of jasper, then the belief that argillite was used prior to jasper receives tacit assent. If, however, it was the earlier *Indians* who used argillite, and gradually discarded it for the various forms of flint, then we ought to find workshop sites older than the time of *flint* chipping, and others where the two minerals are associated. This, as has been stated, has not been done. Negative evidence this, it is admitted, but, when considered in addition to the positive evidence of position in undisturbed soil, it has a value that must not be overlooked. Sufficient positive evidence to clear away *all doubt* of the presence of an earlier people than the Indian on the Atlantic sea-board of America will probably never be forthcoming, yet, to the minds of candid inquirers, there is a degree of probability in the interpretation of known facts that closely hugs the bounds of certainty.

Wholly convinced that valid reasons have been given for assuming that the chipped stone implements made of argillite are older than the similar patterns of weapons made by the Indians, it is desirable to determine whether these ruder objects are the handiwork of the ancestors of the Indians of historic times, or that of the descendants of palæolithic man, and therefore the relics of a preceding, prehistoric race.

A forcible objection that has been urged against the assumption, as it was held to be, of a pre-Indian occupancy of our sea-coast, is the difficulty of realizing that a people sufficiently advanced to make so

* "Primitive Industry," chapter xxxi, p. 453, Salem, Massachusetts, 1881.

well-designed a weapon as the argillite spear-head should not have utilized stone in various other ways to meet their wants, precisely as the Indian did subsequently. No other form of implement than these spear-heads was clearly associated with them, except when found on the surface, and so not clearly separable from the true Indian implements associated therewith. Recently, the occurrence of a stone hammer, traces of fire—charcoal—and a flat stone bearing marks of a hammer or rubbing-stone, at a depth of nearly three feet below the surface, has rendered it quite probable that a proportion of the surface-formed relics of these patterns should be regarded as of other than Indian origin. If we examine a series of the stone implements of the only other American race—the Esquimaux—we will find that not only is the variation in pattern very considerable, but that precisely such forms of domestic implements as are now in use in the Arctic regions, among the Chukches, are common "relics" in New Jersey. In his recent volume of Arctic explorations, Professor Nordenskiöld describes a series of stone hammers and a stone anvil, which are used together for crushing bones.* Every considerable collection of stone implements gathered along our sea-board, anywhere from Maine to Maryland, contains numbers of identical objects.

While many of these hammers and mortars are unquestionably of Indian origin, no valid reason can be urged that a proportion of them are not of the same origin as the argillite spear-heads. Indeed, grooved stone hammers have been found quite deeply imbedded in the sand—as deep as the usual depth at which argillite arrow-points occur; but this, of itself, is scarcely significant. So unstable is the surface of the earth, where sand prevails, that the actual position, when found, of any single specimen, is of little importance. It is only when thousands have been gathered with great care, and under the most favorable circumstances, that any inferences may be drawn. This is true of the argillite arrow-heads, of which thousands have been gathered, and presumably true of the hammers and mortars, because such implements are common among an American race which uses also such spear-points as are so abundant in New Jersey. The similarity between a Chukche spear-point figured by Nordenskiöld † and an Esquimau spear figured by Lubbock ‡ and the New Jersey specimens is very striking. Of course, such similarity may be considered as mere coincidence, but that it has an important bearing on the question becomes evident when the many circumstances suggestive of a pre-Indian race on the Atlantic sea-board are collectively considered. Singly, any fact may be held to be of little or no value; but when many of like significance are gathered together, they are self-supporting, and the one central fact becomes established.

Basing the supposition that palæolithic man was not the ancestor

* "Voyage of the Vega," New York, 1882, p. 483. † Ibid., p. 571.

‡ "Prehistoric Times," second edition, London, 1868, p. 493, Fig. 218.

of the American Indian, because there is evidence warranting the belief that "the Indian was a late comer upon the extreme eastern border of North America—indeed, the oldest distribution of the American races does not antedate the tenth century," and therefore "the appearance of the Skrælling (Esquimau) in the Sagas, instead of the Indian, is precisely what the truth required" *—basing the supposition thereupon, it was suggested † that in the Esquimaux we should find the descendants of that oldest of all mankind—*homo palæolithicus.*

Having given the strictly archæological reasons for dissociating certain of the stone implements found in New Jersey, let us now briefly refer to the historical evidence bearing upon this question. Have we any references to Esquimaux dwelling in regions significantly south of their present habitat? If there are such, then it is at once evident that the weapons and domestic implements of such people must now be buried in the dust of their ancient southern dwelling-places, and, these same spots being subsequently tenanted by the Indian, his handiwork must also be mingled with that of his predecessors.

The literature of this subject can be sufficiently outlined by reference to two authors. Major W. H. Dall, in "Tribes of the Extreme Northwest," ‡ remarks: "There are many facts in American ethnology which tend to show that originally the Innuit of the east coast had much the same distribution as the walrus, namely, as far south as New Jersey." I submit the rude argillite arrow-heads found in certain localities in such abundance, and at a significant depth, as an additional fact, tending in the same direction.

In Rev. B. F. De Costa's admirable *résumé* of Icelandic literature § there is given abundant evidence—ay, proof—that the people dwelling along the coast of Massachusetts, 900 to 1000 A. D., were not the same race that resisted the English on the same coast six centuries later. The descriptions of the people seen by the Northmen show that, of whatever race, they were well advanced in the art of war, and used not only the bow, but hatchets and the sling. They were "men of short stature, bushy hair, rude, fierce, and devoid of every grace." ‖

It need, therefore, only be remembered that the relationship between the true palæolithic implements and those of more advanced finish and design is evident to every one who carefully examines a complete series. At the same time, the student is confronted with reliable historical evidence of the occupancy of the Atlantic sea-board by the Esquimaux as far south as New Jersey.

Does not the impression derived from strictly archæological

* "Popular Science Monthly," vol. xviii, No. 1, p. 38, November, 1880, New York.

† "Peabody Museum Report," vol. ii, p. 252, Cambridge, Massachusetts.

‡ "Contributions to North American Ethnology," vol. i, p. 98, Washington, 1877.

§ "Pre-Columbian Discovery of America," Albany, 1868.

‖ "Popular Science Monthly," November, 1880, p. 38, New York.

studies, that all the stone implements of our Eastern sea-board are not of one origin, go far to confirm the position of the historical student that an earlier race than the Indian once resided here?

De Costa remarks: "During the eleventh century the red-man lived upon the North American Continent, while the eastern border of his territory could not have been situated far away from the Atlantic coast. In New England he must have succeeded the people known as Skrællings. Prior to that time, his hunting-grounds lay toward the interior of the continent. In course of time, however, he came into collision with the ruder people on the Atlantic coast, *the descendants of an almost amphibious glacial man.*"

This "amphibious glacial man," I submit, is he who fashioned the rude palæolithic implements, that, with bones of extinct and Arctic mammalia, are now found in the glacial drift of our river-valleys; and his "descendants," a rude people, with whom the Indian finally came in contact, were those who fashioned the plainly finished argillite arrow-heads and spears that are now, in part, commingled with the elaborate workmanship of the latest race, save one, that has peopled this continent.

BODILY DEFORMITIES IN GIRLHOOD.

By CHARLES ROBERTS, F. R. C. S.*

I HOPE the time is not distant when a careful study of the living model of the child and the adult, and the whole period of the development of the one into the other, will form a part of the student's ordinary course of anatomy and physiology, as such knowledge is essential to the surgeon engaged in removing and preventing deformities of the body. Orthopedic surgery as a specialty is a great evil both to the profession and the public. The specialist who concentrates all his attention on a narrow field of study and practice is tempted to exaggerate its importance, and to analyze and disintegrate his facts till he loses sight of their relation to and their dependence on each other; while, on the other hand, the general practitioner is disheartened and repelled by the apparent complication of the subject, and is induced to hand over to the specialist many cases which he is quite competent to treat, or, as is too often the case, to undervalue the importance or deny the existence of many deformities. How else can we explain the difference in practice between the fussy mechanical ingenuity with which many professed orthopedists treat the slightest deformities of children—which, by the way, they often tell us are only visible to their specially trained eye, and are hidden from that of the

* Late Assistant-Surgeon to the Victoria Hospital for Sick Children, etc.

family doctor—and the *sang-froid* of the general practitioner who meets the difficulties by the administration of a few doses of steel and quinine and rest in the recumbent position?

No deformity of a child's body gives rise to so much alarm to parents, or is the subject of greater diversity of treatment among medical men, as lateral curvature of the spine, and this is due, I believe, to an imperfect acquaintance with its origin. Specialists are accustomed to treat lateral curvature, knock-knee, and flat-foot as distinct deformities, while in truth they are all links in the chain of one deformity. Lateral curvature may arise in different ways, but in all cases it is due to the loss of the lateral balance of the body in the upright position, and is the result of an effort of nature to maintain the center of gravity of the body and support the head and shoulders in the position which requires the least expenditure of muscular effort. The paralysis, wasting or loss of a limb, or the shortening of one of the legs by disease of joint, rickets, knock-knee, or flat-foot in growing children, will produce lateral curvature, and these are its chief if not its only causes. It is not a deformity arising from general debility, and I do not think it can be produced, as is often asserted, by an awkward sitting position, as in writing and other school occupations. The curvature of the spine which results from these causes is antero-posterior, or what is commonly called round-shoulder (non-carious). The tendency of debility, whether local or general, is to bring the body into the prone or recumbent position, and not to tilt it on one side.

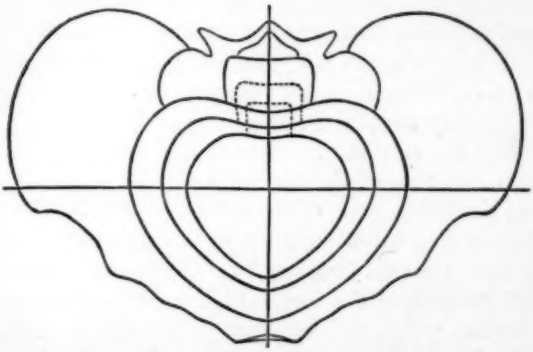
Setting aside the cases of lateral curvature in children who have been affected with rickets, disease of joints, paralysis or loss of a limb in early life, and which affect both sexes and all ages equally, what may be called the idiopathic or acquired deformity is rarely found in children of either sex under the age of nine or ten years, and very rarely in boys above that age. It is, indeed, almost peculiar to girls verging on puberty, and is as often found in strong and healthy as in weak and delicately built girls, and most commonly in those who are too fat and heavy for their stature and age. It is a deformity which is less common among the laboring classes than among the rich and well-to-do, and is largely associated with a life of indolence and luxury.

A careful examination of the subject has satisfied me that this acquired lateral curvature in girls is due to the change in the position of the lower limbs, resulting from the development of the pelvis from the infantile to the female type a year or two before the accession of puberty. Any one who will examine the figures of young children below this age will find little differences between the two sexes. The legs of young girls are set on the body like those of boys, and, within the limits of their training and dress, they can run as well and as gracefully as boys; but as puberty approaches, and the pelvis alters

its shape, the heads of the femora are removed farther from the center of gravity, and at the same time become rotated forward by the widening of the pelvis, and especially of the outlet of the pelvis. The effect of these changes is to bring the knees closer together, and to produce the weak-kneed condition and the awkward running gait peculiar to women. This condition of the limbs is well seen in pictures and statues of the nude figure, and it is often exaggerated by the artist or sculptor, probably to give a more distinct idea of a woman's helplessness or modesty. The knee-cap in women looks straight forward, while in men it is turned a little outward; and in women the knees touch, or even overlap each other, while in men they are quite free. In running, a woman has to move the knees round each other, and to throw the feet out in a succession of small semicircles, which accounts for the peculiarity in her gait. This gait is not found in young girls before the onset of puberty, and is useful as a diagnostic sign of pelvic evolution long before the ordinary signs appear.

Although this weak-kneed condition is quite normal, it is a fruitful source of deformity in growing girls. A little additional strain will convert it into knock-knee, and, by throwing the weight of the body on the inner ankle, it will quickly break down the arch of the foot and produce flat-foot or complete eversion of one or both feet. It is here, indeed, that nearly all the mischief lies, for according to my experience ninety per cent of the cases of lateral curvature of the spine in girls are associated with flat-foot. This deformity is exceedingly common among women, and a French *savant* recently quoted it as a proof of the physical inferiority of woman to man. To a slight extent flat-foot may exist in all women, as the position of the lower limbs after puberty would seem to produce it, and it may be Nature's plan to promote what anthropologists call marriage by capture; but to a large extent, and in its worst forms, flat-foot is the result of civilization. Indeed, both the highly arched instep and the everted foot are peculiar to civilized peoples, and are absent from the lower races, especially those who go barefoot, and both conditions owe their existence to the wasting of the muscles which flex the toes and foot by the constant use of tight-fitting shoes. In India, where the native workman makes use of his toes with almost the same facility as his fingers, the instep is obliterated by the fleshy bellies of the abductor of the great toe and the short flexor of the toes, which stretch across the arch from their attachment to the heel-bone. The wasting of these muscles is of little importance to us who have no need to use our toes in detail; but it is far otherwise with the deep flexors of the foot and toes which are attached to the leg-bones, and whose tendons pass under the ankle-joint and arch of the foot and form their chief support. It is, indeed, from the wasting or inaction of the deep flexor muscles, coupled with the turning out of the toes which fashion has imposed upon us, that the ankle and arch of the foot give way under the changed position

of the limbs in girls at puberty, which I have described; and what is remarkable, and not easily explained, the deformity generally occurs only in one foot, or is greater in one than in the other. In this way, however, the legs become of unequal length, and we have obliquity of



The diagram shows the relation of the brim of the pelvis in the child, at puberty, and in the adult female, from measurements of pelves in the museum of the Royal College of Surgeons. The want of parallelism of the two inner pelvic curves shows that in the change from the infantile to the female type evolution takes place chiefly behind, and that the legs must be rotated forward and inward. The dimensions are—Child: breadth, 83 mm.; length, 73; index, 114. Young female: breadth, 112 mm.; length, 85; index, 132. Adult female: breadth, 143 mm.; length, 108; index, 132. The indices of the young female and the adult are the same, but the bones of the former are not united together.

the pelvis, and consequently lateral curvature of the spine to correct the balance of the body, and bring the head and shoulders into the line of the center of gravity. Flat-foot also produces, or exaggerates, the natural disposition to knock-knee in girls, which, in its turn, adds to the inequality in the length of the two legs. Some observations recently made in America show that even in adults of both sexes the two legs are rarely of equal length, and there must be, therefore, slight lateral curvature in all persons, and it is probable that these natural curves become exaggerated, as in the development of round shoulder the large antero-posterior curves of the spine are exaggerated. It is to the wasting or non-development of the fleshy parts of the deep flexors of the toes or foot that Europeans owe the small ankle and the comparatively large calf of which they are so proud as distinguishing them from the lower races. It is a distinction, however, which is more than counterbalanced by the ugliness and inconvenience of flat-foot, to which it frequently gives rise. The ingenuity of an Edison could not devise a machine so favorable to the production of flat-foot as the tight-fitting, high-heeled, long-topped boot at present worn by girls. Not only does the rigidity of the front part cramp the action of the muscles, but the high heels place the foot at such an angle with the leg that the tendons are of least use in supporting the ankle-joint, and the long tops hamper the development of the muscles in the remainder of their course. The high heels, moreover, push the center of gravity forward on the arch of the foot, and by propping up the heel gives greater lev-

erage, and a greater space for the arch to fall when once it gives way. In the majority of cases the mischief would stop when the arch reached the level of the natural heel, but the heels of boots favor a still greater fall, which ends in eversion of the foot. It is difficult to understand how women submit to the discomfort of wearing high-heeled boots, or can be so cruel as to let their daughters wear them. It is true they give a fictitious height to the body, and disguise the slighter forms of flat-foot, but on the other hand they exaggerate the severer forms, and the boots are entirely wanting in proportion. Zeising's law of proportion requires that the sole and the heel should have the relative length of three to two, like that of the normal foot.

In treating the deformities of the spine and legs incident to healthy girls, it is obvious that attention must be directed, in the first instance, to correcting the deformed knees and feet. The very first signs of the giving way of the arch of the foot, which is easily detected by examination, by growing pains, and especially a change of gait, should be met by the wearing of flat-soled, well-fitting boots, with India-rubber or felt pads inside to support the arch, and special exercises favorable to the development of the deep flexor muscles. At puberty, and for two or three years before, the growth is very vigorous, and in both stature and bulk girls shoot ahead of boys of the same age, the period of rapid growth of boys coming later. From ten to fourteen years the stature of girls increases at a uniform rate of two inches per year, except at thirteen, when it is two inches and a half; but the weight increases at a much greater rate. At ten years girls add four pounds, at eleven six pounds, at twelve ten pounds, at thirteen twelve pounds, and at fourteen and fifteen eight pounds to their weight, and this sudden addition to the weight tells rapidly on ankles, feet, and knees, placed at a disadvantage by concurrent change in the position of the lower limbs by the evolution of the pelvis and the cramping of the muscles by tight boots. The arch of the foot often breaks down in the course of a few weeks, without warning or apparent cause, and in girls in perfect health, and especially those of an indolent habit. Fortunately, the remedy is as easy and complete, if applied promptly at the beginning and adhered to persistently, as it is difficult and unsatisfactory if put off till the deformity is firmly established. Support to the arch of the foot prevents the formation of knock-knee and lateral curvature of the spine. When it fails to do so, the knock-knee can be corrected by the temporary application of long splints, especially in bed at nights; but no apparatus is necessary for the curvature of the spine in its earlier stages, as it will disappear on restoring the lateral balance of the body, and all treatment will be useless until this is done. Much walking or standing should be avoided, and short but vigorous gymnastic exercises substituted, and when possible the recumbent position assumed. Sitting on the ground or on a sofa, in the cross-legged, Oriental position, serves to expand the pelvis, evert the knees

and invert the ankles, and counteract all the deformities; while sitting on chairs with the legs crossed one over the other directly favors them. It is probable that most children spend too much of their time on their feet, and that their power of walking is very much overrated. Running is the natural gait of all young animals, and children always run if left to play by themselves. The dire effect of standing and walking in producing flat-foot in children is shown by the following statistics, taken from my paper on "Flat-foot," in the St. George's Hospital Reports (1872–'74): Of 10,000 children, between the ages of eight and thirteen years, which were examined, about one third were school-children living in country towns and agricultural districts, another third were school-children living in manufacturing towns, and the remainder were factory-children. Among the first, 17·1 cases per 1,000 of flat-foot occurred; among the second, 30·7 cases per 1,000; and among the third—i. e., the factory children, who were employed five hours daily standing, walking, and carrying weights—79 cases per 1,000 of flat-feet were found. Among the latter the deformity was found to increase rapidly with age—i. e., with the longer period of employment in factories. Thus:

Of the age of	8	years,	15·1	per 1,000 had	flat-foot.
"	9	"	45·6	"	"
"	10	"	51·2	"	"
"	11	"	104·2	"	"
"	12	"	132·4	"	"

At the period when these observations were made (1873) children were allowed to commence work in factories at the age of eight years, instead of ten as now, and the low rate of 15·1 per 1,000 represents the normal rate before the strain of labor has begun to tell on the children's feet.

There can be little doubt that children are made to stand and walk far too much both at home and at school. Standing at lessons, parade-exercise, and much of the military drill in schools are injurious to both boys and girls, and especially to the latter. Instead of listless standing about, or taking long walks with adults, children should be permitted and encouraged to play lively games, which they will generally do even if left to themselves, to dance, and to perform short but spirited gymnastic exercises with apparatus. Exercises which develop the muscles of the feet and ankles, such as hopping and skipping, are especially necessary for girls; and still better than these are the admirable exercises preparatory to stage-dancing taught at the National Training-School for Dancing.* These exercises are directed to the development of the muscles and the free action of the joints of the lower limbs, and are far preferable to the languid movements of ordinary dancing. For the development of the muscles of the trunk and

* Under the direction of Madame Katti Lanner.

arms the excellent system of gymnastics for girls recently established by a lady * in various parts of London, with the approval, after careful and repeated inspection by myself, of Dr. Richardson, Mrs. Garrett Anderson, and others, is all that can be desired. The Swedish and other exercises effected without apparatus are of little use, as idle and indolent girls who stand most in need of physical training easily comply with the form, but evade the spirit and hearty compliance which such systems demand. These systems lack motive to complete an exercise, while simple apparatus, such as balls, dumb-bells, and bars, compel it by keeping the end in view, and giving an impetus to its performance. With half the care which mothers spend on dressing and decking-out their children, often in unsuitable clothing, they might, with a little help from their medical advisers, prevent most of the deformities which mar the physical beauty, comfort, and health of their offspring; and no time seems more appropriate than the present for directing the attention of medical practitioners, and through them of parents, to the means of attaining these objects, as the short walking-dresses worn by women and girls at the present time reveal to all of us to what a great, indeed unexpected, extent the ugly deformities of the feet and ankles to which I have referred exist, especially among the well-to-do and higher classes.—*Lancet.*

TIME-KEEPING IN LONDON.

By EDMUND A. ENGLER,
WASHINGTON UNIVERSITY, ST. LOUIS, MISSOURI.

II.

THE distribution of the Greenwich signals from the General Post-Office in London is effected by means of the Chronopher or Time-carrier,† shown in perspective in Fig. 6, and in front elevation in Fig. 7.‡ To this instrument the hourly signal from the observatory is sent by means of a special under-ground wire. Branching out from it are four groups of wires: 1. *Metropolitan*, running to points in London only. 2. *Provincial Short*, to points not more than fifty miles from London, as Brighton, etc. 3. *Provincial Medium*, to points farther away, as Hull, etc. 4. *Provincial Long*, to extreme points, as Edinburgh, Belfast, etc. * The ends of each of the four groups are brought

* Miss M. A. Chreiman, 69 Petherton Road, N.

† There are actually two of these; the one shown in the figure is the new and larger one.

‡ For a description of the chronopher, from which the above is condensed, and for drawings from which Figs. 7, 8, and 9 have been made, the writer is indebted to William H. Preece, Esq., Superintendent of Telegraphs, London.

* The Greenwich signals are sent into Ireland only for purposes of comparison; Dublin time is used throughout the island.

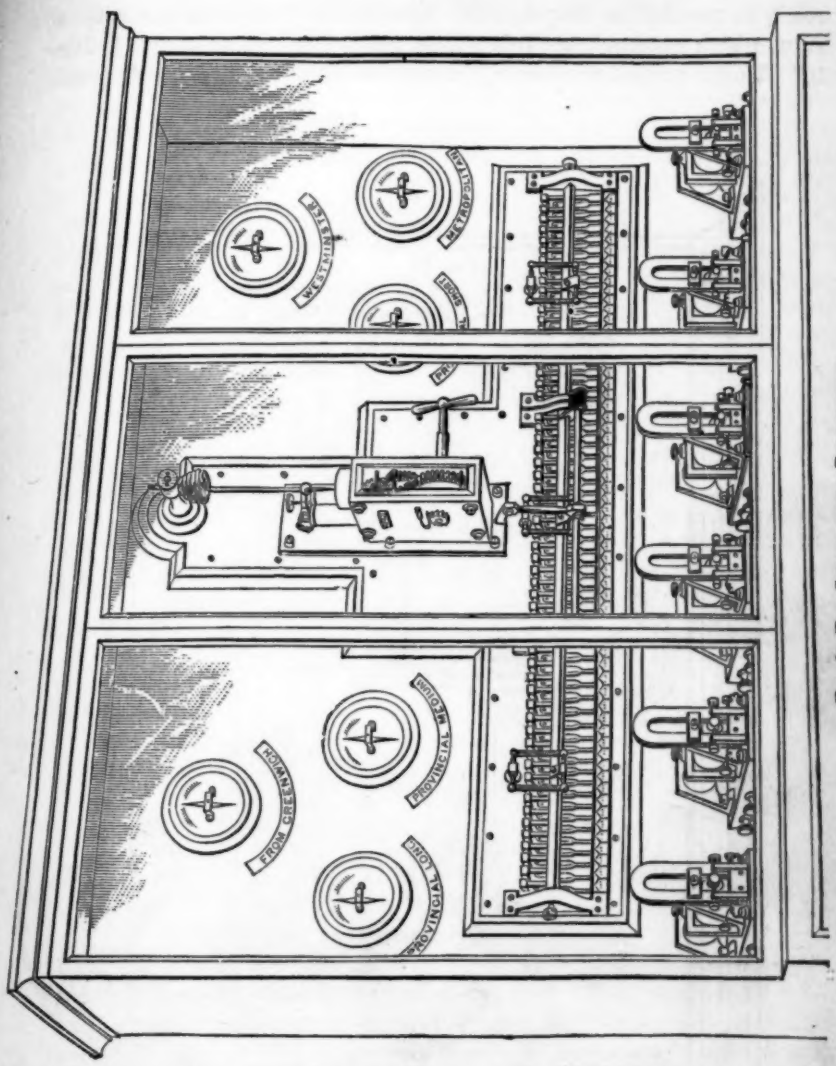


FIG. 6.—THE CHRONOSPHERE.—PERSPECTIVE.

together, and each group has a separate relay, in order that the shorter may not unduly deprive the longer lines of their share of the current. The four relays are all worked by the hourly signal from Greenwich, and therefore act simultaneously. The lines of the *Metropolitan group* are used only for time purposes, and are therefore always connected with their relay, and distribute the signals hourly. But the lines of the other groups are in use generally for ordinary telegraphic purposes, and distribute time-signals only at ten and one o'clock. At these hours, therefore, the wires must be switched off from their ordinary duty, and placed in communication with their respective relays to be

ready to receive the time-signals. The electrical working of the apparatus which accomplishes this will be understood by reference to Fig. 8.* Under normal conditions, the current from the observatory passes

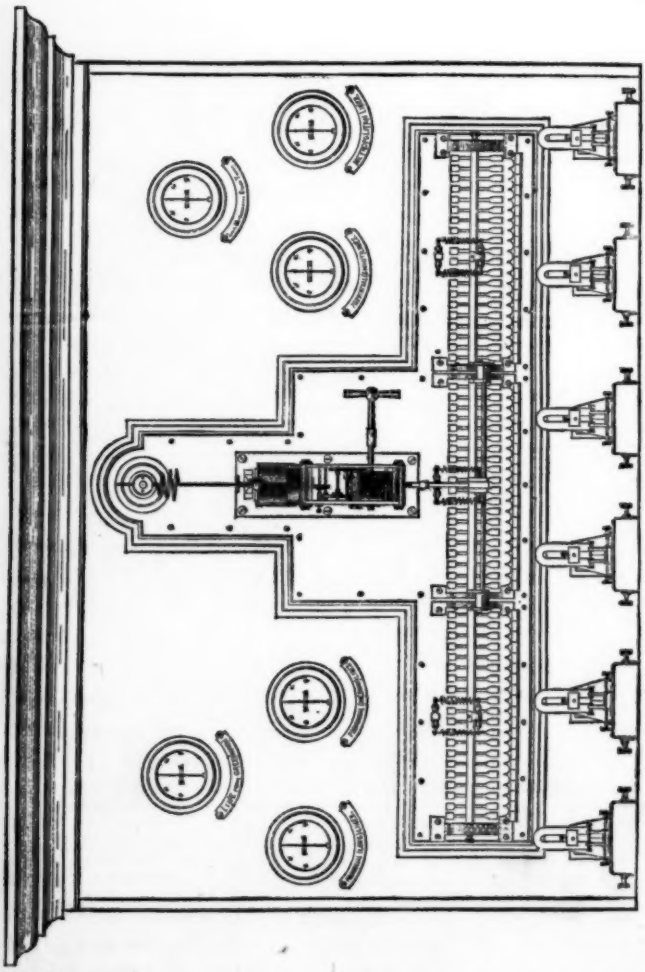


FIG. 7.—THE CHRONOPHER.—ELEVATION.

directly through the chronopher, and out at the galvanometer G′, to the tower-clock at the Houses of Parliament, Westminster. This clock has a gravity escapement, and a metallic compensating pendulum, very similar to the pendulum of the Sidereal Standard, already described, and runs with a rate of less than one second per week. The

* The small figures 1, 2, 3, 4, to the right of Fig. 8 and to the left of Fig. 9, show the connection between the wires.

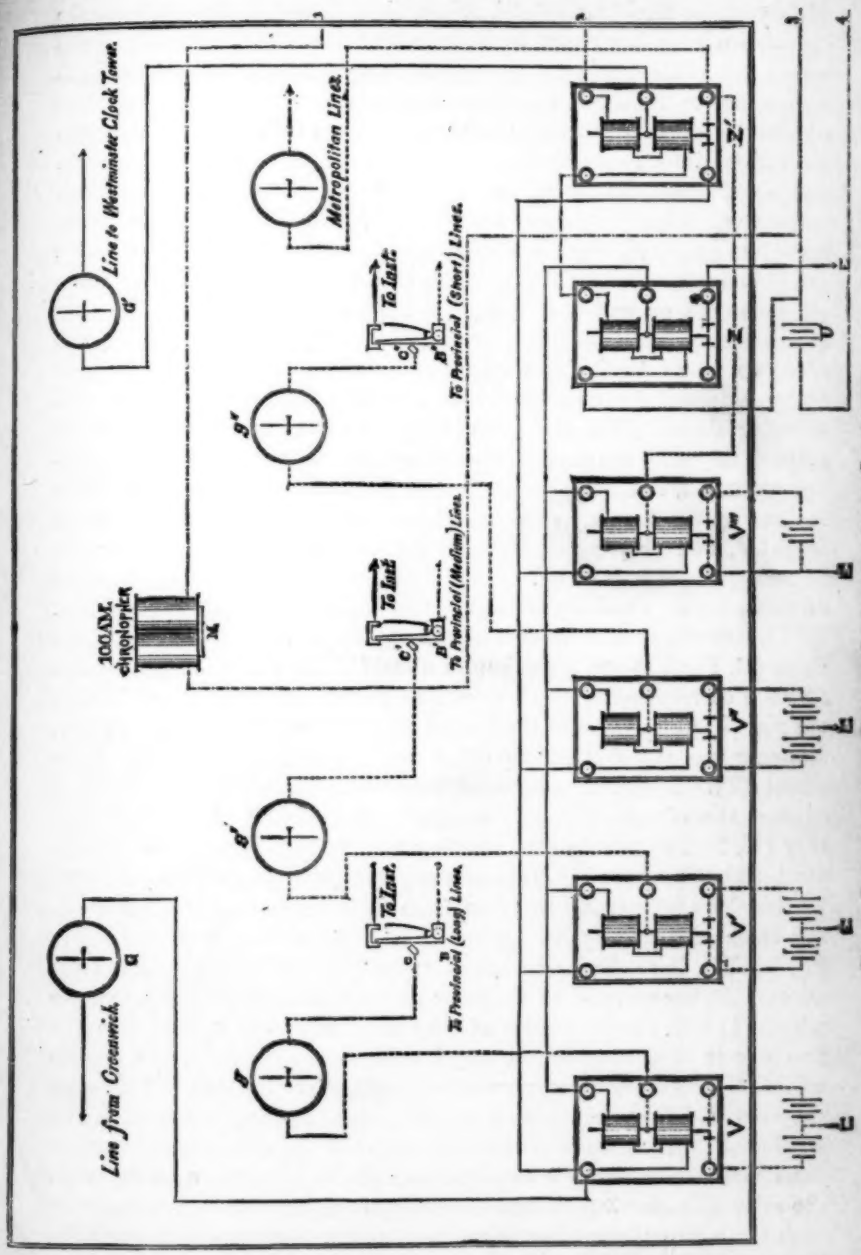


FIG. 8.—DIAGRAM SHOWING ELECTRIC CONNECTIONS OF THE CHRONOPHER.

current from Greenwich in no way controls the Westminster clock, but is simply used for rating the clock by comparison; when change of rate is necessary, weights are added or removed at the pendulum.

Each of the line wires is in permanent connection with one of a set

of jointed vertical bars (B, B′, B″), which, except at the times for the signal, are kept in contact by springs with cocks in the circuit of the wire; but at the times for the signal a long metallic bar (C) acting as a cam (better shown in Fig. 7, in front of the vertical bars), is made by clock-work to disconnect all these bars from their instruments. The bar (C) is divided into three parts, corresponding to the long, medium, and short provincial lines, insulated from each other, and connected respectively with the bars of the relays (V, V′, V″) through the galvanometers (*g*, *g′*, *g″*, Fig. 8). The left or rest contacts of these relays are in connection with the zinc poles of separate batteries, whose copper poles are grounded, so that, when the bars of these relays are put in connection with the line wires, a zinc or "preliminary" current is ready to be sent out; this current prevents the distant relays from being actuated by contacts or accidental currents, and serves as a warning signal. The right-hand contacts of the relays are connected respectively with the copper poles of separate batteries whose zinc poles are grounded, so that, when the bars are moved over to the right (which is done by the incoming Greenwich current), the outgoing current is reversed, and this constitutes the signal. The relay V″ is for distributing the signals only to points in the metropolis, and, as the wires on these lines are under ground, no "preliminary" current is necessary.

The mechanical operation of the apparatus is as follows: On the clock (R, Fig. 9) there is an ebonite wheel (W) in which are two notches (N, N′) corresponding to 10 A. M. and 1 P. M. Shortly before 10 A. M. the pin (P) on one arm of the forked lever (L) falls into the notch (N), allowing the end (Q) of the other arm to rest on the ebonite hour-wheel (T). About two minutes before the hour, the end (Q) comes against the contact (S), and completes the circuit of the local battery (U, Fig. 8) through the starting magnet (M, Fig. 9) and sets the clock-train (shown in Fig. 7) in motion, pressing the cam (C) against the vertical bars, disconnecting them from their instruments, and connecting them respectively, in groups as already shown, with the relays (V, V′, V″), in readiness to send a "preliminary" current to the line wires. At ten seconds to the hour an insulated pin (*i*, Fig. 9) on the wheel (T) lifts the lower arm of the forked lever (F), so that its upper arm comes in contact with a small cam on the arbor of the escape-wheel (K). This contact closes the circuit of the battery (U) through the coils of the two relays (Z, Z′). The relay (Z) puts on the earth connection at (E), for the four relays (V, V,′ V″, V‴), so that the current from Greenwich may be received and divided between them, while the relay (Z′) disconnects the Westminster clock-wire and connects it with the metropolitan lines to receive the signal from the relay (V‴). The relays (V, V′, V″, V‴) have a resistance of 5,000 ohms to allow of the splitting of the current. At precisely ten o'clock the Greenwich signal reverses the current on the lines, and thus gives the exact time. At ten seconds past the hour the contact between H and K is

broken, the relay-bars go back to their normal position, the train-work moves away the cam (C), and restores the vertical bars to connection with their instruments.

The apparatus which effects the shunting at one o'clock is somewhat different in construction. The pin (P, Fig. 9) falls into the notch (N′),

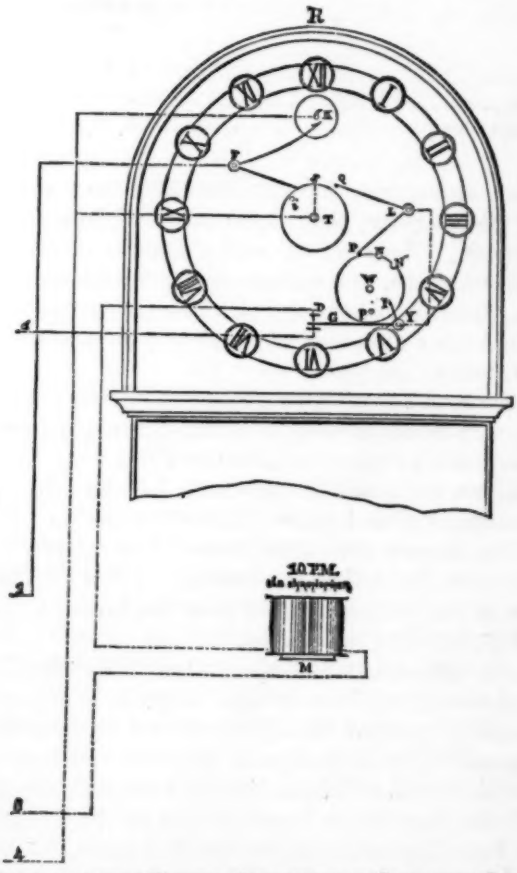


FIG. 9.—DIAGRAM SHOWING ELECTRIC CONNECTIONS OF CLOCK WITH CHRONOPHER.

a pin (*p*) on the wheel (W) coming against the arm (I) of the forked lever (Y) raises the flexible arm (G) against the upper contact (D), so that the circuit of the local battery (U) is closed through the starting magnet (M), which operates the one o'clock train-work.

Wires which receive both the ten and one o'clock signals pass through both switching arrangements.

For the hourly currents on metropolitan lines the relay (V‴) serves, by closing the circuit of the battery (U) at the contact (K), the rest of the apparatus remaining inoperative.

The actual interval during which the Greenwich as well as the provincial wires on which the time-signal is distributed are kept in circuit being only twenty seconds, the chance of interruption from contact currents is reduced to a minimum.

The batteries in use are large Leclanché cells, and the power is distributed as follows :

	Copper or "time" battery.	Zinc or "preliminary" battery.
Long lines	80 cells.	60 cells.
Medium lines	60 "	45 "
Short lines	40 "	30 "
Metropolitan lines	40 "	.. "

The Greenwich signal, thus distributed by the chronopher, goes to all parts of the kingdom, and affects receiving instruments provided for the purpose. These are of various kinds ; ordinary telegraphic sounders, electric bells, and galvanometers have been used with success to note the arrival of the signal. The current has also been made to drop time-balls on the tops of buildings, to expose a model time-ball to view, and to fire guns.

To test the accuracy of the signals, experiment has been made by returning a wire to Greenwich from the chronopher, and comparing the signal received on this wire with the signal sent from the observatory ; no difference could be perceived between the indications of two galvanometers placed side by side showing the passage of both currents. The signals were thus shown to be entirely reliable. But it does not seem likely that the chronopher will be introduced elsewhere, because simpler means have been devised for splitting up the current and distributing the signals.

The whole system is under the control of the Post-Office Department. They own the wires—which, except in London, are the ordinary telegraph-wires—and therefore contract to keep them in order, to clear them each day at the signal-times, and to deliver at these times the Greenwich signal. Maintenance of lines and apparatus not the property of the department is undertaken by the department for any period not less than one year at specified rates. A simple form of agreement has been prepared, which every renter is required to sign. This agreement, as a rule, is for not less than three years, and is terminable at three months' notice given previous to the end of the fixed term, or, failing such notice, on payment of such sum as the department may accept instead. But where the expense of construction is considerable, the term must not be less than from five to seven years, the latter period being stipulated when the proposed line is in an outlying district and would be specially provided for a single renter, and when it is not probable that there would be other renters.

The annual charges for the use of wires and apparatus are as follows :

From London to the country: * For the 10 A. M. signal, £12 to £17 = $60 to $85. For the 1 P. M. signal, £27 to £32 = $135 to $160. In London: For the hourly signal within a radius of two miles from the General Post-Office, £15 = $75. But if the person desiring the signal is off the line of the telegraph, he must pay, besides a stipulated rental, an additional sum for the use of the wire which the department is compelled to put up specially for him. The rental is in all cases payable yearly in advance.

In 1880 there were one hundred subscribers to the system, of whom nineteen were in London, and eighty-one scattered through England, with a few in Scotland and Ireland.

Besides this general automatic distribution of the time-signals, a considerable distribution of the 10 A. M. signal goes on by hand. At that instant the chronopher makes a sound which an operator sits ready to catch by ear. Upon hearing it he immediately dispatches a signal by the ordinary telegraphic instrument, and this signal is received at six hundred or more places, which again serve as distributing points for more distant places. These are usually railway or post offices in towns not supplied by the chronopher, which by virtue of authority become the regulators of the clocks of the surrounding district.

The wire from the observatory to London Bridge carries signals hourly from the mean solar standard to a clock at the station of the Southeastern Railway, which by changing connections sends Greenwich time to different stations along the line as may be required. For this service the Southeastern Railway gives the observatory the use of its wire daily, for a few minutes, at 1 P. M. At this time the current from the observatory drops the time-ball at Deal, which was erected in 1855, to give time to the shipping in the Downs, and is the only official coast time-signal. The ball in falling sends a "return" signal to the observatory. The record shows that about once in two months high wind prevents the raising of the ball, about once in six weeks it fails to fall on account of some fault in the electric connections, and about once a year it drops out of time. Under such circumstances it is dropped correctly at 2 P. M.

By special arrangement with the observatory a few London jewelers receive the hourly Greenwich current on private wires. This they use for the correction of their own time-keepers and in some cases for distribution. Prominent among these are the Messrs. Barraud & Lund, of Cornhill, who have patented a method for the synchronization of clocks. Their plan is put forward as a simple and effectual means of setting any number of ordinary clocks to the same standard time. All attempts to control clocks have been set aside as impracti-

* Difference in charge for the same signal depends on the length of wire which the department is compelled to put up specially for the subscriber. The one o'clock signal is more expensive, because the wires are busier with telegraph duties at that hour than at 10 A. M.

cable, and a system adopted whereby the clock is automatically "set to time" every hour, or at such intervals as may be arranged. The apparatus can here be described only in brief. There are three essential parts, the *standard clock*, the *distributor*, and the *synchronizer*.

The standard clock is an astronomical regulator with mercurial pendulum and dead-beat escapement, and closes an electric circuit at the sixtieth second of each hour. Another regulator, technically called "Lobby," is for use in case of accident to "Standard." They are so connected that a single failure of "Standard" to send out a signal at the proper time brings "Lobby" into action for the next signal, and, in order that "Lobby" may always be ready for service, an intentional breakdown of "Standard" occurs automatically at eight each morning, and the nine o'clock signal is sent out by "Lobby"; which of the two is in operation is shown by indicators connected with the clocks (Fig. 10).* Should a breakdown occur, the indicator of "Standard" would show *missed*, and that of "Lobby" *at work*.

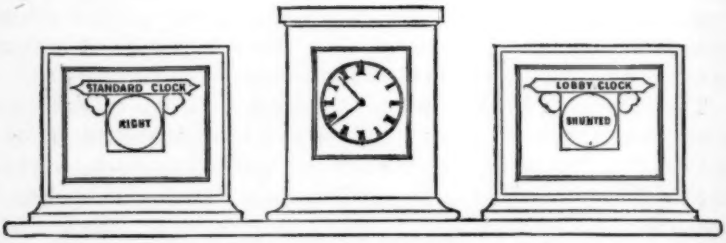


FIG. 10.—BARRAUD AND LUND'S INDICATORS.

The error of the standard clock is determined daily by comparison with the Greenwich signal. An ordinary dotting chronograph is set to the standard clock, and the Greenwich signal makes a dot on the chronograph-dial which gives at once the error of the standard and can be read off at leisure. It is corrected by electric means. The pendulum carries a small permanent magnet which swings over a resistance-coil about $\frac{1}{16}$ inch distant. The coil is connected with the commutator in the test-box (Fig. 11), consisting of a clock commutator with plugs for "Standard" and "Lobby," a current commutator with plugs for "Fast" and "Slow," and a small time-piece, shown at the top. The time-piece has only a minute-hand, and is made so as to stop itself and break circuit at XII, but closes circuit when running. The working is thus: Suppose "Standard" is found to be slow. Plugs are inserted for "Standard" and "Slow," and the hand of the time-piece is set back a required number of minutes. It then runs to XII and stops. In this interval the action between the magnet and the coil has exactly corrected the standard clock. For every $\frac{1}{16}$ second of

* Figs. 10, 11, 12, and 13, have been reduced from drawings in "The Railway Engineer," London, by permission of Messrs. Barraud & Lund.

error the hand of the time-piece must be set back five minutes. When the setting is done, no further attention is required, all else being automatic.

The distributor (shown in Fig. 11) consists of twelve contact-springs, each connected with a line of wire running through a district of London, and twelve contact-screws, each connected with a battery.

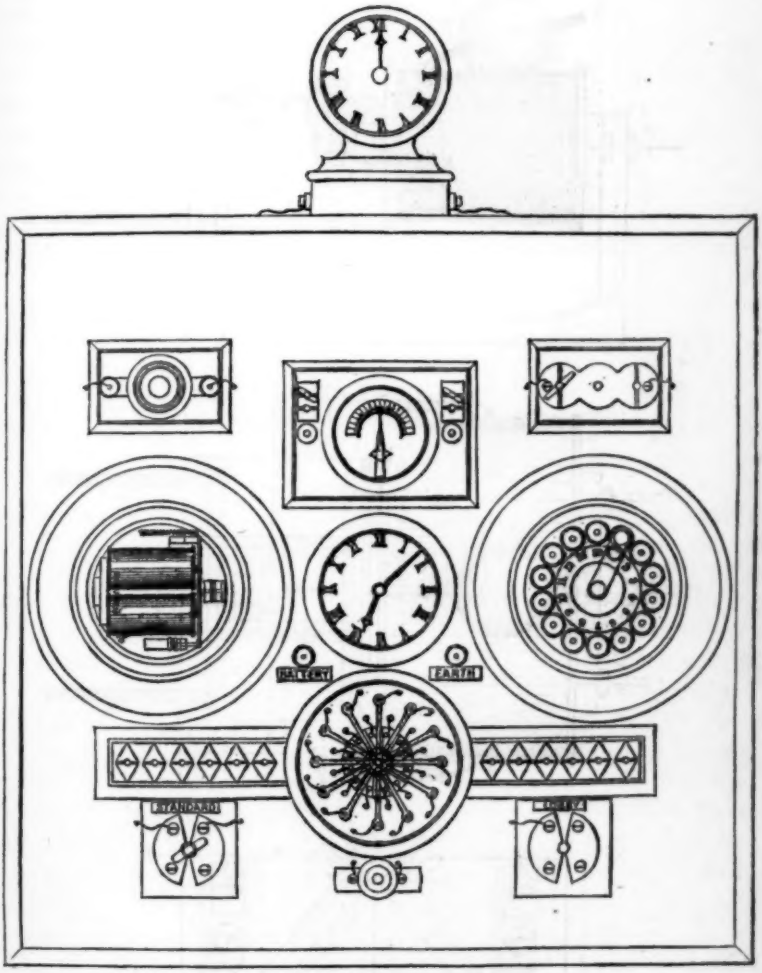


FIG. 11.—TEST-BOX.

The springs converging to the center press up against a small plate, one inch in diameter, which is controlled by an electro-magnet in the circuit of the current which the standard clock sends out hourly. When the signal comes, the plate is pulled down and presses every

spring against its contact-screw, and the signal goes out over each of the lines.

The synchronizer is the receiver of the signal, and consists essentially of an electro-magnet, in the circuit of one or other of the lines from the distributor, with armature carrying two counterpoised levers

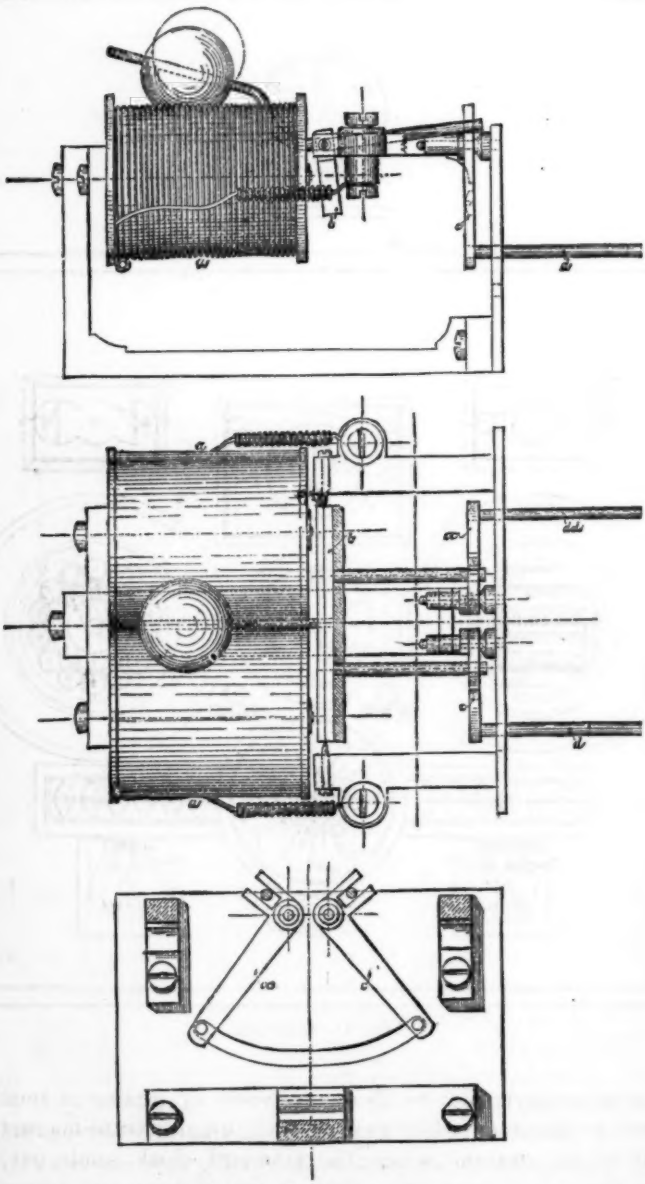


FIG. 12.—THE SYNCHRONIZER.

each provided with a projecting pin. When the signal arrives, the electro-magnet attracts its armature, and the two pins are brought close together. The mechanical operation will be understood by reference to Fig. 12, where a side elevation, a plan, and a front elevation are shown. This apparatus is fastened to ordinary clocks just back of the dial-plate (Fig. 13). A curved slot is cut through the dial for a short space on each side of XII, and through this the pins project. When, at the end of the hour, the signal arrives, the two pins are pushed together and bring the minute-hand exactly to XII. The position of the pins before and just after the operation is shown in Fig. 14. Evidently the clock must not be in error more than two minutes or so; but, as the hand is set every hour, any ordinary clock can be kept right by this device.

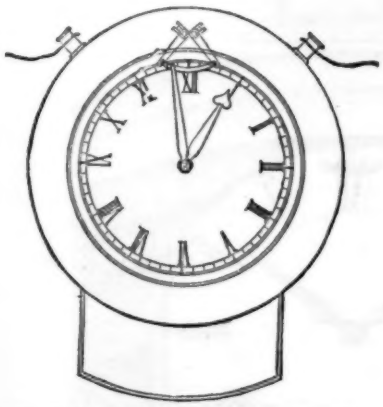


FIG. 13.—FACE OF CLOCK WITH SYNCHRONIZER ATTACHED.

FIG. 14.

Other ingenious arrangements have been added to guard against danger, always present to long lines of wire, and for testing the condition of the lines, but a description of them can not here be given.

The advantages claimed for the system are:

1. That any number of clocks of any varying sizes can be synchronized to any agreed standard time-keeper.

2. That the mechanism is, when not in momentary use, entirely detached from the works of the clock.

3. That it can be applied to existing clocks.

4. That any failure in the transmission of the time-current leaves the clock going in the ordinary way, to be "set to time" by the next completed current.

5. That the clocks are kept to time whether having otherwise either a gaining or losing rate, even if such rate amounts to many minutes a day.

In London the system has been in successful operation for about five years, and has been used over a wire four hundred miles long. The subscribers number about five hundred, among them many railroads and public institutions.

In connection with the synchronized clocks, Messrs. Barraud and Lund have also established time-bells and flashing-signals, which afford

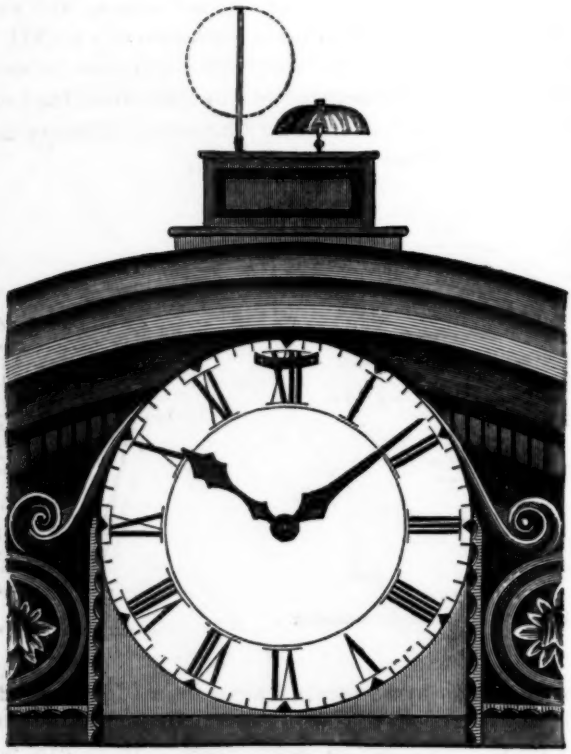


FIG. 15.—BARRAUD AND LUND'S TIME-BELL.

time-signals both to the ear and eye. These are shown in Figs. 15 and 16. The bell is an ordinary electric bell, and is rung by the regulating clock, which closes the circuit at the instant the signal is desired. The flashing-signal consists of a red vertical disk on a vertical axis, which normally shows only its edge, but is made to revolve once on its axis in four sudden jumps, by simple mechanism in connection with electro-magnets, when the regulator, by closing the circuit, sends the current. The appearance is that of two flashes of red as the disk revolves.

In many places where noise prevents hearing a bell, the flashing-signal becomes a necessity. It is in use at the London Stock Ex-

change, and serves to indicate the exact instant of noon.

The method of synchronizing clocks is becoming rapidly popular throughout the world, and has been patented in most civilized countries. It is already in use in Australia and South America, and in some of the countries on the Continent of Europe. In this country, at New Haven, Connecticut, a "Standard Time Company" has been formed, who have bought the patent for the whole of the American Continent, and are now engaged in manufacturing synchronizers. An effort will be made by them to bring about a concerted system of time-signaling throughout the country. Local affiliated companies will be formed, and there is little doubt that the great simplicity and practical success of the method, combined with its cheapness, will secure its extensive adoption in all the large cities of the country.

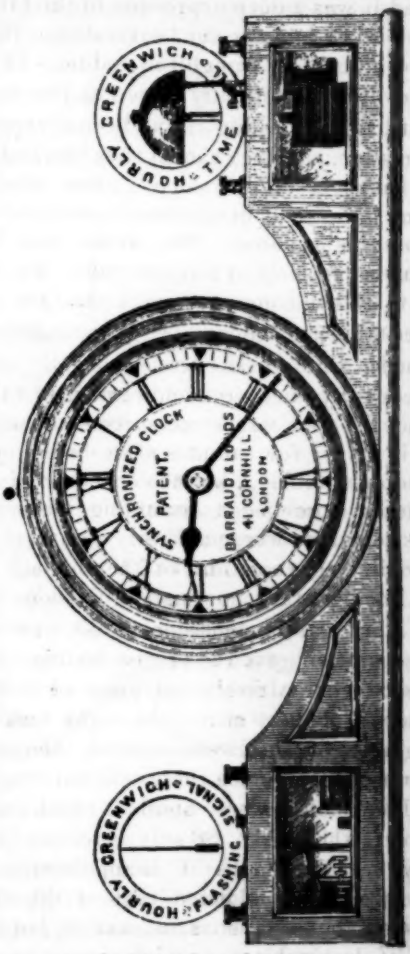


FIG. 16.—BARRAUD AND LUND'S TIME-BELL AND FLASHING-SIGNAL.

A MASTODON IN AN OLD BEAVER-MEADOW.*

BY SAMUEL LOCKWOOD, PH. D.

ON the 7th of June, 1882, a farmer, while cutting a drain through a meadow on his farm at Freehold, New Jersey, observing the appearance of bones, stopped the workmen, and sent for me to inspect the place. This I did the next morning. Approaching the spot, I

* "On a *Mastodon Americanus* (Cuvier), found in a Beaver-Meadow at Freehold, New Jersey, by Samuel Lockwood." Read at the Montreal meeting of the American Association for the Advancement of Science, August, 1882.

found it was a deep depression in the farm, and the site suggested the possibility of an ancient beaver-dam. But in that case a stream should be seen flowing through the middle. There was none there. I learned afterward that formerly there was just such a stream, but that in order to utilize the meadow it had been diverted to one side of the valley or depression, and the channel thus left had been filled up by taking from the banks or higher slopes; after this it was planted with corn. I found a drain about eighteen inches wide in progress of construction across this meadow. The ditcher had literally cut through a buried monster precisely at a point which took away a part of the bases of the tusks and some portion of the face of the animal. It was indeed a veritable mastodon. Digging under my direction was at once resumed. Both tusks were soon fully exposed, and the left one was successfully uncovered and removed to the side of the drain. Before removal I took exact measurements, and fortunate it was that I did, for in a very few minutes after being put on the dry ground it separated or unfolded, like the concentric layers of an onion, and in a few minutes more began crumbling into powder. The concentric rings thus separated were uniformly a quarter of an inch thick, so that these unfoldings gave no hint of the animal's age, for the ivory was so fine and compact that no smaller divisions were discernible. This splendid ivory was in consistency like new white cheese, and the surfaces of separation gave the precise feeling to the fingers as when they are passed over a freshly cut piece of soft cheese. The left tusk was removed almost entire; the right tusk was nearly all removed, and fragments of both were secured, though very soft and unsatisfactory, for upon drying even these selected fragments crumbled to powder.

Four molars were obtained, which were found in exact relative position to the tusks. So soft were the bones that all further digging only provoked sighs of disappointment. Of course, the position of the two tusks indicated that of the skull. We tried carefully to uncover the head so as to save it, but in vain. The spade took up a spit of dark substance which proved to be the arched forehead of the brute, which also crumbled away after a short time. But a wonderful story that short time told. This high-vaulted forehead might please some amateur phrenologist, but as a cerebral indicator of intellect it was an immense fraud. It was the genuine elephant forehead, "only more so." On cleaning it, by gently pulling out certain tufts of fine roots and vegetable fiber, this great piece of bone was literally honeycombed with air-cells, each one big enough to hold a hickory-nut. These were the extraordinarily developed frontal sinuses.

But a word about the tusks. The two were in the normal position, as of the animal lying on its right side, with the back toward the ancient stream. The ditcher had nearly destroyed one of the tusks by attempting to get it out before my arrival. The upper one, that is, the left tusk, had lost all that portion which had been cut through

by the ditching. There was in the side of the ditch enough visible before the uncovering to show that the destruction had taken away much of the base, being nearly all that part of the tusk containing the pulp-cavity. The surface of the soil was carefully removed, and measurements taken. The part uncovered was four feet four inches long. Between this and the place of insertion in the skull was about eighteen inches—and for insertion two feet should be allowed —when the entire length of each tusk would be seven feet eight inches, and the weight of the ivory in each hardly less than two hundred pounds. The tusks had a slight upward curve.

The digging was continued next day, the whole area being examined. The peculiar dark stain covered a space not less than fifteen feet in length and six feet in width. It was evident that the head was inflected toward the chest. It is pretty certain, then, that a line taken from the base of the trunk to the root of the tail would not be less than seventeen feet.

The burial-place of this great beast is to me of intense interest. The body lay on its side, on a hard sand bottom, the upper parts being surrounded and but thinly covered with muck, or vegetable peat. I am satisfied that it died on the dry bank of an ancient stream. Now came a singular discovery which served as a key to the difficulty. Lying on the skeleton at different parts were the sticks or heart-remains of red cedars (*Juniperus Virginiana*, L.) ; they were beaver-logs. Here a singular piece of experience came to my aid. I had quite recently discovered and studied the details of two fossil beaver-dams but two miles west of this place, and the physical features of this mastodon's burying-place were in all respects indicative of a former beaver-dam. In fact, no other hypothesis could account for these sticks, with others of different woods, which have been exhumed in this meadow. It is observable that a pond made by beavers has in time its meadow as a natural consequence, and that, after the pond is deserted by these animals, the dam breaks down slowly, and, as the pond area decreases, the swamp area increases, and a growth of vegetation sets in which becomes the peat-bog, afterward the meadow. The place where the mastodon lay in course of time became covered by the waters of the pond, for beavers keep lengthening their dam to increase the area of the pond, and only stop so doing when the natural opportunities of the situation are exhausted. Of course, it was only the skeleton of the beast which was buried, and the bones might have been there long before peat-growth began over them. This explains the decomposition of the bones, for peat is antiseptic, and they should have been preserved, but it was a slow burial, and slow decay had long before set in. A curious fact seems to me to confirm the above. The huge air-cells in the bones and the great pulp-cavities of the tusks were packed solid with vegetable matter, but so unlike the imbedding peat as to be remarkable. This packing, which filled

the slightest crevices and open spaces in the bones, was in every case *root*-fibers. I took out of the pulp-cavity of one tusk a compact cone of these rootlets. I have seen precisely the same thing when opening a small drain-pipe which had become choked with the roots of a tree.

Two facts have much impressed me—the great geological antiquity of the mastodons as a race, and the very recent existence of the individual we are discussing. The race began in Miocene time; this individual lived in the Quaternary age, and well up into the soil-making period. There is little if any differentiation of the molars. The cusps, or teats, on the crown are high and prominent, although I think it must have been one of the very last of its tribe. Though the race came before those great castors now extinct, this individual was contemporary with the existing beaver, and doubtless with the aboriginal man.

It is singular that in the present controversy respecting the subsidence of a part of the eastern coast-line of the United States, I have never seen the testimony of the mastodon put in evidence. As already said, this animal has run through a long stretch of geologic time. I saw a tusk taken from the Trenton gravels of New Jersey which belong to the ice age, or glacial epoch. I have part of a tusk taken from the shore in Monmouth County, New Jersey, after a storm. This storm from the sea had washed away the drift which covered an ancient swamp, in which this relic, with other bones, had been entombed. But that swamp had been far inland, sufficient for a depression to exist far enough away from the action of the sea to enable it to support a non-marine, sub-aquatic vegetation. The subsidence had allowed the sea to come up and uncover that creature's grave. Last summer, at Long Branch, I saw a fine mastodon's tooth which was taken up by fishermen out at sea. I have also some fragments of a mastodon's tooth, besides an almost entire one of remarkable size. I consider it the sixth,* or last tooth developed. It was given me as coming from Long Branch, where it was obtained so long ago that its history was forgotten. I detected upon it the microscopic skeletons of marine *Bryozoa*, the same species that I have often found on the shells of our modern oysters. This tiny animal can only attach itself to a clean anchorage in the clear sea-water. Hence this tooth was evidently got from the sea; and, more, its old grave of mud or peat was long ago invaded by the sea and churned up, so as to float it away, leaving the tooth on the clean, sandy ocean-floor.

* Not counting the tusks, the elephant has only eight teeth in his mouth at any one time—two molars on each side of each jaw. The forward tooth of each pair is pushed forward until it disappears. The back one then is pushed forward, and replaces the one lost. This goes on until six molars have appeared on each side of each jaw, so that the full-aged animal has in its life-time twenty-four molars. The tusks are monstrously developed incisors. While the true elephant has normally but two tusks, the male mastodon has four, two small ones in the lower jaw, which, however, are shed before adult age.

So it is plain that the mastodon came into what is now New Jersey ere the ice-sheet began. It receded south before it. It followed the thawing northward, and so again possessed the land. It occupied this part of the country when its shore-line was miles farther out to sea than it is to-day. Here it was confronted by the human savage, in whom it found more than its match; for, before this autochthonic Nimrod, Behemoth melted away.

CURIOSITIES OF SUPERSTITION.

By FELIX L. OSWALD, M. D.

SOME of the higher animals have a peculiar faculty for accustoming themselves to various kinds of poison; and man, especially, often owes his ruin to that unfortunate talent, for the instinct of taste can be so perverted that the vilest and originally most repulsive substances become the most seductive.

There is a curious analogy between this corruptible sense and the intellectual (rather than moral) constitution of the human mind. It may be doubted if any man ever loved injustice for its own sake, or voluntarily connived at its habitual exercise. History proves that successful tyrants could maintain themselves only by favoring a strong party at the expense of the weak. Pisistratus, Hiero, the elder Dionysius, Vespasian, Mohammed Baber, and Haroun, miscalled Al-Raschid, were the idols of the army and of the poor. Even Mehemet Ali had his redeeming qualities. Men can stand only a limited amount of iniquity. But their intellectual tolerance has no such limits. Persistent misrulers come to an evil end, but the founder of a sect, a school, or a new creed, may

> ". . . reign without dispute
> In all the realms of nonsense, absolute"—

and it even seems as if in the struggle for supremacy the most insane dogmas had the advantage over moderately absurd ones, just as opium is apt to supersede brandy and tobacco. In China, where the neutrality of the government gave all creeds a fair chance, the fate-worship of Confucius was eclipsed by the Buddhistic worship of sorrow. In Greece, the orthodox polytheists held their own against all heresies. The pure theism of Abd-el-Wahab was throttled by the champions of the Sunnitic traditions. In Rome, where the struggle for existence was fought out by fourteen or fifteen different creeds, theists, pantheists, Nature-worshipers, agnostics, and all kinds of speculative philosophers had to yield to the Asiatic miracle-mongers with their Nature-hating fanaticism and Buddhistic crotchets; and Buddha himself was

baffled by that *ne plus ultra* of systematic insanity, the creed of the orthodox Brahmans. Buddhism, the worship of death and sorrow, has, indeed, almost vanished from the land of its birth. Its infatuations prevailed against the primitive religions of the Mongols, Siamese, Cingalese, Tartars, and Thibetans, but in Hindostan the cow and monkey worshipers carried the day; the champions of Sakya-Muni had found their match, and, after an hierarchical rough-and-tumble fight of fourteen hundred years, their doom was sealed by a crushing defeat. In vain the Dalai Lamas convoked council after council; in vain the bonzes howled on the highways and prayed day and night on the public streets—the monkey Hanuman triumphed, and at this moment a hundred and twenty million Hindoos are ready to risk their lives in defense of a creed which, in the words of Baron Orlich, "combines the extremes of priestly arrogance with endless ceremonies and the most extravagant dogmatic absurdities." The clerical tyranny of Brahmanism may have been surpassed in papal Rome, and the complexity of its rites in Thibet; but its dogmatic absurdity is *sui generis*, and can really defy competition. "*Credo, quia absurdum videtur*," said the chief theologist of the Patristic era, but the quintessence of the Athanasian confession would seem insipid to devotees who have been fuddled with the opium of Brahma; and Father Huc expressed merely the recognition of a practical impossibility when he advised his countrymen not to send any more missionaries to Hindostan. The clergy, missions, and convents of the Spanish church cost the country a yearly aggregate of forty-two million dollars—after all, less than twenty per cent of the total national revenue—and the emissaries of that church may well shrink from the competition with a priesthood that persuades its constituents to sacrifice *two fifths* of their field-crops to a greedy swarm of four-footed divinities. The hunchback ox (*Bos Bramanus*) enjoys the freedom of every East Indian town. Even Calcutta has its "cow-dung suburbs" (the British soldiers use a stronger term). He defiles the sidewalks, monopolizes the tree-shade, and mingles with the crowd of the market-place. If he collects his perquisites by force, the natives remark that giving is more blessed than receiving; if he knocks them down, they feel with Cardinal Newman that the devotion of the truly faithful shows itself in the endurance of oppressive measures. In every larger city there are walled tanks where sacred crocodiles await the contributions of the pious. In Benares they subsist upon the rent of a real-estate legacy and occasional donations of the wealthy produce-merchants. But even the poorest of the poor contribute to the support of the sacred baboons. The bhunder-baboon and the Hanuman (*Cercopithecus entellus*) have every reason to regard themselves as the primates of the animal kingdom, and man as a humble relative, gifted with certain horticultural talents for the purpose of ministering to the wants of his four-handed superiors. Northern India is dotted with *mahakhunds*, or monkey-

farms, where thousands of long-tailed saints are provided with shelter, respectful attendants, and three substantial meals a day, on the sole condition that they shall renounce their sylvan haunts and bless the neighborhood with the influence of their holy presence. Sick monkeys are sent to the next bhunder-hospital, generally a well-endowed and well-managed institution with a special *dhevadar* or responsible major-domo. The little town of Cawnpore has eight such infirmaries, Benares twenty or twenty-five, some of them with a subdivision for incurables and chronic dyspeptics!

To support these institutions is deemed a privilege as well as a duty. Troops of children, with garlands around their ankles and wrists, march in procession to offer the first-fruits of the season to the major-domos of the next mahakhund. An *embarras de richesse* often obliges that functionary to sell a portion of the donations and invest the surplus in the guarantee funds of the institution. In very poor districts, like Baroda and the northern part of the Madras Presidency, a protracted famine sometimes exhausts these funds, and reduces the *menu* of the sinecurists to two meals a day and half-measures of the weekly treacle allowance, the full rice ration being generally guaranteed by deposit-drafts on a public store-house. At such times, when human beneficiaries would feel grateful for the least assistance, the four-handed *protégés* become peevish. They often abscond and try their luck on the public highways, where orthodox pilgrims would, indeed, part with their last crust rather than disregard the wants of a sacred baboon. If hunger emboldens a low-caste monkey to approach the precincts of a mahakhund, the irate boarders sally forth and pursue him with a rancor as if they suspected him of being accessory to the irregularities of the purveyance system.

When the (Mohammedan) Sepoys destroyed the large monkey-asylum of Behar, the citizens of Nusserabad, though themselves on the verge of famine, promptly organized a relief committee. A provision-wagon, drawn by lean horses and leaner fakirs, drove through the city collecting comestibles, while the conductor of the team, in a sort of sing-song chant, recounted the sufferings of the holy long-tails: "They mourn among the roofless ruins. They sit hungry-eyed, waiting in vain for the arrival of a moderate refection. No bread, no sago-cakes, no rice for the righteous ones, while many a sinner" (with a gleam of suspicion) "regales himself, perhaps, with *yed-na-saccar*" (a sort of blanc-mange). "Their young ones look leaner than scrub-palm lizards. While they fast the just trembles; the eye that looks unmoved may soon be moved by retaliative calamities. Promptly, ye faithful, contribute, contribute!" (C. Ritter's "Travels in Hindostan and Siam," vol. ii, p. 210).

Victor Jacquemont estimates that the Bengal Presidency alone contains sixteen hundred monkey-asylums, supported chiefly by the very poorest class of the population. In the rural districts of Nepaul

the hanumans have their sacred groves, and keep together in troops of fifty or sixty adults, and, in spite of hard times, these associations multiply like the monastic orders of mediæval Europe; but they must all be provided for, though the natives should have to eke out their crops with the wild-rice of the Jumna swamp-jungles.

The strangest part of the superstition is that this charity results by no means from a feeling of benevolence toward animals in general, but from the exclusive veneration of a special subdivision of the monkey tribe. An orthodox Hindoo must not willingly take the life of the humblest fellow-creature, but he would not move a finger to save a starving dog, and has no hesitation in stimulating a beast of burden with a dagger-like goad and other contrivances that would invoke the avenging powers of the Society for the Prevention of Cruelty to Animals. Nor would he shrink from extreme measures in defending his fields from the ravages of low-caste monkeys. Dr. Allen Mackenzie once saw a swarm of excited natives running toward an orchard where the shaking of the branches betrayed the presence of arboreal marauders. Some of them carried slings, others clubs and cane-spears. But soon they came back crestfallen. "What's the matter?" inquired the doctor; "did they get away from you?"

"Kapa-Muni," was the laconic reply, "sacred monkeys." Holy baboons that must not be interrupted in their little pastimes. They had expected to find a troop of common makaques, wanderoos, or other profane four-handers, and returned on tiptoe, like Marryat's sergeant who went to arrest an obstreperous drunkard, and recognized his commanding officer. Unarmed Europeans can not afford to brave these prejudices. Captain Elphinstone's gardener nearly lost his life for shooting a thievish hanuman; a mob of raging bigots chased him from street to street till he gave them the slip in a Mohammedan suburb, where a sympathizing Unitarian helped him to escape through the back-alleys. The interference of his countrymen would hardly have saved him, for the crowd increased from minute to minute, and even women joined in the chase, and threatened to cure his impiety with a turnip-masher.

This impiety, say the Brahmans, is merely the effect of ignorance. Foreigners are apt to mistake a hanuman for a common yahoo, a filthy, impudent bush-whacker, while the facts are as follows: The hanuman is a lineal descendant of the great hero-ape who helped the Light-gods in suppressing the power of Ravan, the prince of darkness. The war raged for years with varying success, and the sun-spirits were once almost nonplused, when their long-tailed ally bethought himself of a stratagem that completely discomfited their adversaries: He set the whole Island of Ceylon afire and escaped just in time to attend a grand council of the sun-gods, who then rewarded his services by an hereditary sinecure. In the midst of a solemn war-dance he discovered that his own tail was ablaze, and had to save himself by a hurried trip to the

eastern Himalayas, where he extinguished the flames in a lake which to this day bears the name of Bhunder-pouch, or Monkey-tail-pond—a fact which alone suffices to refute the sophisms of narrow-minded skeptics ("Asiatic Researches," vol. xiv, p. 44).

Crocodiles have a prescriptive right to our surplus of non-nitrogenous food, butter, goat-cheese, and the offal of the heretical meat-shops. They are not divine, in a stricter sense, but "water-pure," free from the taint of hereditary sin, and their merits are often rewarded by a quasi-immortality, synchronistic with the duration of this planet. Their peccadilloes must be condoned; the slayer of a *gavial*, or sacred saurian, is an enemy of the public, for his deed is apt to result in a general calamity. In Agra a Buddhistic Chinaman once obtained the post of crocodile-warden, but was soon after arraigned for criminal neglect. A party of foreigners had visited the tank, and a couple of gavials followed them toward the gate, in quest of cold lunch, according to the theory of the prosecution, while the strangers suspected them of homicidal intents, and, finding the gate closed, retreated behind a tree and fired their pistols as fast as they could load. The negligent warden at last interfered, but too late; both crocodiles had been fatally wounded, and one of the victims happened to be a gavial, a most reverend, and, barring *such* accidents, immortal amphibian that had inhabited the tank since the time of Menu. The counsel for the defense not only denied the charge of neglect, but proved that the prehistoric reptile had been imported not more than five years before. The court dismissed the case, and the Chinaman volunteered to pay half the costs, but the Brahmans never forgave him. He lost his place and, like the Rev. Augustus Blauvelt, was accused of having betrayed his master.

The Koran contains some rather incomprehensible ordinances, unless Professor Sale should be right that Mohammed prescribed them as preparatory exercises of faith. The founders of several monastic orders seem also to have thought it necessary to strengthen the orthodoxy of their disciples by periodical renunciations of common sense, but the Brahmans have carried this principle to an even greater length. According to the Yagur-Veda, a spiritual-minded man should renounce the world after following its ways long enough to see the son of his son. To be quite safe, he had better go as soon as his hair begins to get gray. A conscientious *Sannyassi*, or "renouncer," should make his home in the forest, live upon fruits and edible leaves, and let his hair grow. His tunic should consist of bark, his lower garments of untanned antelope-skin. He must elevate his soul by the contemplation of Brahm and humble his body by taking occasional rambles on all-fours. This would be bad enough, but, in order to fulfill all righteousness, a Sannyassi must wear wet clothes in the cold, and pass the midsummer noons between two blazing fires, in order to correct the humors of his spirit. With a view of washing away his worldliness

he must not only bathe twice a day, but expose his body to every shower of the rainy season (Weber, "Indische Literatur-Geschichte," p. 395).

Yet this regimen was merely a palliative, prescribed to all refugees from the temptations of this world, and positive sinners had to expiate their guilt by quite different penances. In this higher art of self-torture Buddhism unquestionably bears off the palm of insanity. Under the influence of its dogmas Sannyassism became an elaborate system for weaning the human mind—not from the errors of life, but from life itself, a systematic mortification of all natural instincts and desires, a negative method of suicide. The "renouncer" had first to ascertain his dearest wishes and deliberately thwart them; abandon his friends, relinquish his worldly ambitions, and forego all gratifications of the senses. He next had to avoid whatever could compensate such sacrifices: emulation, fame, and even the pleasures of self-approbation. The candidate of Nirvana had to subsist on insipid food—millet-seed, for instance, or even cresses ("Asiatic Researches," vol. xvii, p. 238). He had to clothe himself in rags, and renounce all worldly possessions, all earthly sympathies; Buddha Ghoska, the South Indian apostle of the great Nepaulese, goes so far as to warn his disciples against sleeping more than once under the same tree, lest their souls should be contaminated with an undue affection for any worldly object (Schopenhauer's "Parerga," vol. i, p. 317). The civil war of contending dogmas filled India with rival hordes of self-torturing fanatics. Brahmans and Buddhists vied in the invention of new torments. Voluntary affliction became the chief criterion of merit. The Buddhistic monasteries practiced the most approved methods for making life hateful and death desirable; among their ghastly penitents all the monsters of La Trappe could have found their prototypes. Troops of Brahmanic flagellants wandered from town to town; the Sannyassis had regular rendezvous, where their novices could profit by the experience of the accomplished lunatics:

"So gathered they, a grievous company:
Some day and night had stood with lifted arms,
Till, drained of blood and withered by disease,
Their slowly-wasting joints and stiffened limbs
Jutted from sapless shoulders, like dead forks
From forest trunks. Others had clinched their hands
So long and with so fierce a fortitude,
The claw-like nails grew through the festered palm.
Certain who cried five hundred times a day
The names of Shiva, wound with darting snakes
About their sun-tanned necks and hollow flanks . . .
Here crouched one in the dust, who, noon by noon,
Meted a thousand grains of millet out,
Ate it with famished patience, seed by seed,
And so starved on; there one who bruised his pulse

With bitter leaves lest palate should be pleased;
And next, a miserable saint, self-maimed,
Eyeless and tongueless, sexless, crippled, deaf."
(EDWIN ARNOLD'S "Light of Asia," p. 18.)

Or Wieland's satirical *résumé:*

"Der Glaube hiess es heilig, wenn
Der Fliegen, der Heuschrecken frass,
Und Jener gar mit seinem heil'gen Hintern
In einem Ameisen-haufen sass,
Um da andachtig zu überwintern."

Nor are those fancy sketches; such things are practiced in Hindostan to this day. Weber estimates the present number of professional Sannyassis at six hundred thousand; De Lanier at six hundred and fifty thousand; and Max Müller even at one million (*vide* "American Cyclopædia," article "Fakir"). The procession of the Juggernaut still frenzies the out-of-the-way villages of the Punjaub; the Brahma-whirlpool at the junction of the Jumna and the Ganges still claims its yearly hecatombs of human victims. In the southwestern presidencies the English Government has at last succeeded in abating the suicidal epidemics; the suttee-rite, for instance, has been effectually suppressed by fining all accomplices and abettors. But the beast-idolatry still flourishes, and bids fair to outlive the British Tract Society, as it has survived the Portuguese *auto-da-fés.* Crocodile-hunters still take their lives in their hands; the hanuman humbug continues to paralyze horticulture, and the most popular argument of the Nana Sahib demagogues was, not the nepotism of the foreign rulers, not the arrogance and partiality of the British bureaucrats, but the "cartridge-grievance": orthodox soldiers, in loading a musket, had been obliged to open with their teeth a pasteboard cartridge that had been greased with a mixture of steatite and *beef-tallow!*

The origin of zoölatry, or beast-worship, in some of its phases, is not easy to explain. The supreme usefulness of black cattle made them the representatives of the *prithivi mâtar,* the benevolent, all-sustaining earth-mother. Crocodiles are invaluable scavengers, and in the granaries of Egypt cats were indispensable enough to deserve an apotheosis. But how did serpents and monkeys come by that honor? In Africa snake-worship marks the lowest stage of "animism," but nearly every nation seems to have passed through that stage. In a very curious account of the customs and superstitions of the Haytian negroes, Mr. Moreau ("History of St. Domingo," by Mr. L. E. Moreau) describes the Voodoo idol as "a serpent supposed to be endowed with the gift of prescience, which it communicates to its favorite attendants, the high-priest and priestess of the Voodoo temple." This superstition Mr. Moreau believes to have been derived from Whydah,

in Southern Congo, where the French had a trading-post. But did not the Delphic Pythoness likewise derive her name from a serpent, the great Python of Parnassus, begotten in the ocean-mud of the Deucalian Deluge? The Hebrew word *Ob* is the equivalent of the Grecian *ophis* and the Chaldean *oheb*, a dragon, a serpent; and in the Vulgate the witch of Endor, the "woman who had an *Ob*," is described as a *mulier pythonica;* and the "consulters with familiar spirits" (Deuteronomy, xviii, 11) as "men who worshiped *Ob*," the temple of Bel (a contraction of *Ob-El*, the snake-god) was covered with representations of flying serpents, the wings having been added to indicate the swiftness of the miraculous Python—perhaps the prototype of the Chinese dragon, of our "old serpent," and possibly of the mediæval dragon-myths. On one of the temples of Thebes Belzoni discovered "a row of figures representing three human beings resting upon their knees and with their heads struck off. Before them a serpent-god (*un dio pythonico*) erects his crest on a level with their throats, ready to drink the stream of life as it flows from their veins." Columella, the Roman Huxley, mentions a district of the province of Numidia where the natives tried to break the spell of a summer drought by practicing strange rites with a captive serpent. In the mythology of the Edda the Midgard-snake encircles the globe of the whole earth, and the rupture of its folds will usher in the final return of Chaos. According to Plutarch, the Edonian witches of Thrace practiced their charms by the aid of a tutelary deity in the form of a snake, which they carried from hill to hill in search of a propitious conjuncture of times and places; and among the Veddahs of Ceylon Sir Emerson Tennent ("Ceylon: An Account of the Island, Physical, Historical, and Political") found traces of a very similar superstition; The staff of Æsculapius and the *caduceus* of Mercury were entwined with serpents; and, when the pious Æneas sacrifices at the tomb of his father, the "genius of the sepulchre" emerges in the form of a miraculous snake. The two mysterious strangers who announce the mission of Buddha vanish in the castle-hall, and when the messengers of the king follow them to the gate two furtive serpents glide forth: "The gods come ofttimes thus."

Yet Professor Ritter holds that ophiolatry is the oldest form of demonism or devil-worship, the subtile and deadly serpent being the fittest symbol of the tempter. Barthélemy-Sainte-Hilaire inclines to the opinion that the Egyptian god-serpent was the emblem of immortality, the idea being derived *from the shedding of his skin;* the caves of Elephantine bristle with serpent-heads; and the strangest, but possibly the only correct theory, is Sir W. Jones's conjecture that these shapes are nothing but a modification of that rude symbol of the *vis generativa*—the old Indian phallus.

Monkey-worship is peculiar to Hindostan, and can hardly be explained by the usefulness or the superhuman attributes of poor Hanuman. Yet its antiquity is attested by the sculptures of Ellora and

the oldest traditions of the Eastern Aryans. Should it be a sort of inverted anthropomorphism—a typical form of *ancestor-worship?* Dr. Mivart is perhaps right that there were Darwinians before Charles Darwin, who was merely the first systematic exponent of a very ancient doctrine, for the dogma of metempsychosis itself is possibly nothing but a dimly expressed anticipation of the evolution theory.

"Poor creatures, so humble and so sublime," says Lucretius ("*De Natura Rerum*"—published 45 B. C.), "you must now recognize that you are but the first of earthly animals. Your extraction is very base, you have sprung from very low, but by a slow series of efforts you have raised yourself above your inferior, brethren. I know your origin, but I can not see the goal to which you are tending; yet persevere and work on."

And Buddha:

> "High above Indra's you may raise your lot,
> And sink it lower than the worm or gnat;
> The end of many myriad lives is this,
> The end of myriads that."

And is it so illogical to believe in the possibility of a metamorphic retrogression, as well as progression? Have not the most godlike nations of antiquity "sunk their lot" very nearly to—and in some respects decidedly below—the level of our simian relatives?

Zoömorphism, as Carl Vogt calls the doctrine of metempsychosis, was taught on the banks of the Ganges before Abraham's father sold his stock-farm at Ur, in Chaldea, and there is no stranger fact in the natural history of religion than the ubiquity of this most ancient and most persistent form of supernaturalism. Its dogmas have tinctured the creed of every nation, and often revive in the most unexpected way. It is the basis of the eighteen Puranas of the Egyptian myths, and the traditions of the elder Edda. The strangely suggestive tales of the metamorphoses were probably borrowed from the religion of prehistoric Italy. The nations of Northern Europe had similar superstitions which still survive the exodus of the Druids. The Christian propagandists could persuade the Saxons and Celts to transfer their devotion from Walhalla to Calvary, but they could not shake their faith in were-wolves, kelpies, and amphibious Melusinas.

"That the creed of Mohammed," says Lecky, "should have preserved its pure monotheism and its freedom from all idolatrous tendencies . . . is a fact which we can only very imperfectly explain." But even the Koran did not eradicate the zoömorphic superstitions of the Southern Semites. Professor Brehm relates that his Bedouin guide implored him in the name of the All-merciful not to fire upon a troop of spotted jackals (*Canis pictus*), as these animals embodied the souls of potent wizards who would cruelly revenge the death of a companion. After the death of Caliph Walid—"El Caffer," the infidel, as the dervishes

called him—the citizens of Damascus were frightened by the rumor that the great unbeliever had reappeared in the form of a gaunt hyena that prowled around the city at night; and Abulfeda informs us that before the battle of Aleppo the Karmathians saw a large eagle circling above their vanguard, but were careful not to disturb it, "for they at once recognized the spirit of Abu Taher"—one of their former leaders who had won a great victory on that same battle-field.

Sitting Bull once declared that Father De Smet was the only white man whose word could be implicitly relied upon; but, according to the observations of Mr. W. Everett, this confidence seems to refer to political rather than mythological questions. Mr. William Everett, a government scout at Fort Custer, lived several years among the Sioux, and convinced himself that they believe in the metempsychosis of distinguished chiefs, and on one occasion he saw Sitting Bull himself "making motions with his hands, and talking to a large wolf, which apparrently understood what he said, for, whenever he made the sign for 'Do you understand?' the wolf would throw up his head and howl." They deem it unlucky to kill a white wolf (like the Laplanders, who entertain similar scruples in regard to the white polar fox), and only famine will induce them to shoot at a white-tailed deer. During the hard winter of 1865 six young braves took the risk, and, "were found strangled with marks of fingers on their throats and horrified looks, as if they had seen something awful" (*vide* "Popular Science Monthly," vol. xxi, p. 422).

The Tyrolese mountaineers have an equally weird superstition which their priests have not seen fit to discourage, namely, that an unbaptized child is changed into a Flüh-vogel (a bird with a peculiar wailing cry), and has for ever to flit about the desolate shores of the highland lakes; and the Albanian peasants believe that Constantin Kastro, the companion in arms of the famous Scanderbeg, still haunts his native mountains in the form of a black falcon.

[*To be continued.*]

THE GOSPEL OF RECREATION.

By HERBERT SPENCER.

ADDRESS AT HIS FAREWELL BANQUET, NOVEMBER 9TH.

MR. PRESIDENT AND GENTLEMEN: Along with your kindness there comes to me a great unkindness from Fate; for, now that, above all times in my life, I need full command of what powers of speech I possess, disturbed health so threatens to interfere with them that I fear I shall very inadequately express myself. Any failure in my response you must please ascribe, in part at least, to a greatly

disordered nervous system. Regarding you as representing Americans at large, I feel that the occasion is one on which arrears of thanks are due. I ought to begin with the time, some two-and-twenty years ago, when my highly-valued friend Professor Youmans, making efforts to diffuse my books here, interested on their behalf the Messrs. Appleton, who have ever treated me so honorably and so handsomely; and I ought to detail from that time onward the various marks and acts of sympathy by which I have been encouraged in a struggle which was for many years disheartening. But, intimating thus briefly my general indebtedness to my numerous friends, most of them unknown, on this side of the Atlantic, I must name more especially the many attentions and proffered hospitalities met with during my late tour, as well as, lastly and chiefly, this marked expression of the sympathies and good wishes which many of you have traveled so far to give, at great cost of that time which is so precious to the American. I believe I may truly say that the better health which you have so cordially wished me will be in a measure furthered by the wish; since all pleasurable emotion is conducive to health, and, as you will fully believe, the remembrance of this event will ever continue to be a source of pleasurable emotion, exceeded by few, if any, of my remembrances.

And now that I have thanked you, sincerely though too briefly, I am going to find fault with you. Already, in some remarks drawn from me respecting American affairs and American character, I have passed criticisms which have been accepted far more good-naturedly than I could reasonably have expected; and it seems strange that I should now again propose to transgress. However, the fault I have to comment upon is one which most will scarcely regard as a fault. It seems to me that in one respect Americans have diverged too widely from savages. I do not mean to say that they are in general unduly civilized. Throughout large parts of the population, even in long-settled regions, there is no excess of those virtues needed for the maintenance of social harmony. Especially out in the West, men's dealings do not yet betray too much of the "sweetness and light" which we are told distinguish the cultured man from the barbarian. Nevertheless, there is a sense in which my assertion is true. You know that the primitive man lacks power of application. Spurred by hunger, by danger, by revenge, he can exert himself energetically for a time; but his energy is spasmodic. Monotonous daily toil is impossible to him. It is otherwise with the more developed man. The stern discipline of social life has gradually increased the aptitude for persistent industry; until, among us, and still more among you, work has become with many a passion. This contrast of nature has another aspect. The savage thinks only of present satisfactions, and leaves future satisfactions uncared for. Contrariwise, the American, eagerly pursuing a future good, almost ignores what good the passing day offers him;

and, when the future good is gained, he neglects that while striving for some still remoter good.

What I have seen and heard during my stay among you has forced on me the belief that this slow change from habitual inertness to persistent activity has reached an extreme from which there must begin a counter-change—a reaction. Everywhere I have been struck with the number of faces which told in strong lines of the burdens that had to be borne. I have been struck, too, with the large proportion of gray-haired men; and inquiries have brought out the fact that with you the hair commonly begins to turn some ten years earlier than with us. Moreover, in every circle I have met men who had themselves suffered from nervous collapse due to stress of business, or named friends who had either killed themselves by overwork, or had been permanently incapacitated, or had wasted long periods in endeavors to recover health. I do but echo the opinion of all the observant persons I have spoken to, that immense injury is being done by this high-pressure life—the physique is being undermined. That subtle thinker and poet whom you have lately had to mourn, Emerson, says, in his essay on the gentleman, that the first requisite is that he shall be a good animal. The requisite is a general one—it extends to the man, to the father, to the citizen. We hear a great deal about "the vile body"; and many are encouraged by the phrase to transgress the laws of health. But Nature quietly suppresses those who treat thus disrespectfully one of her highest products, and leaves the world to be peopled by the descendants of those who are not so foolish.

Beyond these immediate mischiefs there are remoter mischiefs. Exclusive devotion to work has the result that amusements cease to please; and, when relaxation becomes imperative, life becomes dreary from lack of its sole interest—the interest in business. The remark current in England, that, when the American travels, his aim is to do the greatest amount of sight-seeing in the shortest time, I find current here also: it is recognized that the satisfaction of getting on devours nearly all other satisfactions. When recently at Niagara, which gave us a whole week's pleasure, I learned from the landlord of the hotel that most Americans come one day and go away the next. Old Froissart, who said of the English of his day that "they take their pleasures sadly after their fashion," would doubtless, if he lived now, say of the Americans that they take their pleasures hurriedly after their fashion. In large measure with us, and still more with you, there is not that abandonment to the moment which is requisite for full enjoyment; and this abandonment is prevented by the ever-present sense of multitudinous responsibilities. So that, beyond the serious physical mischief caused by overwork, there is the further mischief that it destroys what value there would otherwise be in the leisure part of life.

Nor do the evils end here. There is the injury to posterity. Dam-

aged constitutions reappear in children, and entail on them far more of ill than great fortunes yield them of good. When life has been duly rationalized by science, it will be seen that among a man's duties care of the body is imperative, not only out of regard for personal welfare, but also out of regard for descendants. His constitution will be considered as an entailed estate, which he ought to pass on uninjured if not improved to those who follow ; and it will be held that millions bequeathed by him will not compensate for feeble health and decreased ability to enjoy life. Once more, there is the injury to fellow-citizens, taking the shape of undue disregard of competitors. I hear that a great trader among you deliberately endeavored to crush out every one whose business competed with his own ; and manifestly the man who, making himself a slave to accumulation, absorbs an inordinate share of the trade or profession he is engaged in, makes life harder for all others engaged in it, and excludes from it many who might otherwise gain competencies. Thus, besides the egoistic motive, there are two altruistic motives which should deter from this excess in work.

The truth is, there needs a revised ideal of life. Look back through the past, or look abroad through the present, and we find that the ideal of life is variable, and depends on social conditions. Every one knows that to be a successful warrior was the highest aim among all ancient peoples of note, as it is still among many barbarous peoples. When we remember that in the Norseman's heaven the time was to be passed in daily battles, with magical healing of wounds, we see how deeply rooted may become the conception that fighting is man's proper business, and that industry is fit only for slaves and people of low degree. That is to say, when the chronic struggles of races necessitate perpetual wars, there is evolved an ideal of life adapted to the requirements. We have changed all that in modern civilized societies, especially in England, and still more in America. With the decline of militant activity, and the growth of industrial activity, the occupations once disgraceful have become honorable. The duty to work has taken the place of the duty to fight ; and in the one case, as in the other, the ideal of life has become so well established that scarcely any dream of questioning it. Practically, business has been substituted for war as the purpose of existence.

Is this modern ideal to survive throughout the future? I think not. While all other things undergo continuous change, it is impossible that ideals should remain fixed. The ancient ideal was appropriate to the ages of conquest by man over man, and spread of the strongest races. The modern ideal is appropriate to ages in which conquest of the earth and subjection of the powers of Nature to human use is the predominant need. But hereafter, when both these ends have in the main been achieved, the ideal formed will probably differ considerably from the present one. May we not foresee the nature of the differ-

ence? I think we may. Some twenty years ago, a good friend of mine and a good friend of yours, too, though you never saw him, John Stuart Mill, delivered at St. Andrews an inaugural address on the occasion of his appointment to the Lord Rectorship. It contained much to be admired, as did all he wrote. There ran through it, however, the tacit assumption that life is for learning and working. I felt at the time that I should have liked to take up the opposite thesis. I should have liked to contend that life is not for learning, nor is life for working, but learning and working are for life. The primary use of knowledge is for such guidance of conduct under all circumstances as shall make living complete. All other uses of knowledge are secondary. It scarcely needs saying that the primary use of work is that of supplying the materials and aids to living completely; and that any other uses of work are secondary. But in men's conceptions the secondary has in great measure usurped the place of the primary. The apostle of culture, as it is commonly conceived, Mr. Matthew Arnold, makes little or no reference to the fact that the first use of knowledge is the right ordering of all actions; and Mr. Carlyle, who is a good exponent of current ideas about work, insists on its virtues for quite other reasons than that it achieves sustentation. We may trace everywhere in human affairs a tendency to transform the means into the end. All see that the miser does this when, making the accumulation of money his sole satisfaction, he forgets that money is of value only to purchase satisfactions. But it is less commonly seen that the like is true of the work by which the money is accumulated—that industry, too, bodily or mental, is but a means, and that it is as irrational to pursue it to the exclusion of that complete living it subserves as it is for the miser to accumulate money and make no use of it. Hereafter, when this age of active material progress has yielded mankind its benefits, there will, I think, come a better adjustment of labor and enjoyment. Among reasons for thinking this, there is the reason that the process of evolution throughout the organic world at large brings an increasing surplus of energies that are not absorbed in fulfilling material needs, and points to a still larger surplus for humanity of the future. And there are other reasons which I must pass over. In brief, I may say that we have had somewhat too much of the "gospel of work." It is time to preach the gospel of relaxation.

This is a very unconventional after-dinner speech. Especially it will be thought strange that in returning thanks I should deliver something very much like a homily. But I have thought I could not better convey my thanks than by the expression of a sympathy which issues in a fear. If, as I gather, this intemperance in work affects more especially the Anglo-American part of the population—if there results an undermining of the physique not only in adults, but also in the young, who, as I learn from your daily journals, are also being injured by overwork—if the ultimate consequence should be a dwin-

dling away of those among you who are the inheritors of free institutions and best adapted to them—then there will come a further difficulty in the working out of that great future which lies before the American nation. To my anxiety on this account you must please ascribe the unusual character of my remarks.

And now I must bid you farewell. When I sail by the Germanic on Saturday, I shall bear with me pleasant remembrances of my intercourse with many Americans, joined with regrets that my state of health has prevented me from seeing a larger number.

THE INFLUENCE OF EDUCATION ON OBSERVATION.

IT was lately remarked in these columns that one of the dangers attendant on education was that it might lessen men's powers of observation. There is no doubt, we apprehend, that this possibility does exist. Bookishness and absence of mind are no new faults among students. Among the more cultivated classes they have, indeed, been for a considerable time in process of diminution, and the last half-century more particularly has seen a great change in this respect. Physical science has roused students, who in former ages would have been abstract thinkers and nothing more, to careful and steady observation of external things. Facilities of traveling have acted as another stimulus in the same direction; and the love of nature has been a power over sentimental minds, and has led them insensibly from a quiet enjoyment of their surroundings to more active investigation. So that altogether the classes which at the present day have the advantage of the higher education are far more observant than were their forerunners of three or four centuries ago; and, though even now many of the mathematicians and philosophers who walk the streets of our universities live largely in a mood of abstract thought, we must be careful of finding undue fault with this, for the inward eye has some claims not lightly to be despised. But, with respect to the mass of the nation, the question we have raised is one that deserves a good deal of attention. Popular education is still in the bookish stage; and, without complaining of what is inevitable, we may and ought to inquire whether literary study does now in the lower ranks promote that vice of inobservance which it certainly promoted in the higher ranks a century or two ago. Equally we have to inquire whether the virtue which is the converse of this error may be fostered; whether and how the study of books may be made to minister to powers of direct observation, instead of being adverse to them, and to assist in the general business of life.

Literary study may conceivably impede our observant faculties,

either by suggesting problems that appear to demand pure thinking alone for their solution, or by imbuing the mind with an ambitious tone, in which the ordinary events of every-day experience are looked upon as unworthy of notice. In the latter case it must be acting mischievously; in the former case it may be mischievous, though it is not always so. If a problem is really of a purely abstract character, it is inevitable that external observation should be lulled during the investigation of it. Newton was in many respects an inobservant, absent-minded man; but without that inobservance he could not have been the master of abstract thought that he was, or have made the discoveries that have been so powerfully beneficial to the human race. But there are many problems which have an appearance of being abstract, and soluble by pure thought alone, in which this is by no means really the case. Questions of ethics, of political economy, of art, are of this nature; they have a delusive appearance of abstraction from the actual world in which we live; and many an inquirer has gone round and round in them in a profitless circle, without being aware that the element needed to render him successful was not brain-power at all, but experience of men and things. The danger, however, that the faculties of observation may be blunted by an excess of abstract thought is not very great in the popular education of the present day. But the danger that they may be blunted by mistaken ambition is a real one. The clever and educated poor will at times despise the common incidents of daily life, in comparison with that larger sphere to which books give them an introduction in imagination, though not in reality. Housekeepers find that servants neglect the pots and pans and dishes, can not find anything when it is wanted, can not see cobwebs in the corners or dust upon the shelves and tables, while their attention is devoted to the pleasures of literature in some, very often questionable, form. Farmers, we have been told, complain of the degeneracy of plowboys from the same cause. True, farmers are a complaining race, and their misfortunes of late years may have made them more querulous than usual; but their testimony should not be quite disregarded. Some considerable application of the maxim that people should do their duty in their own station will be found to give no unneeded help to the observant faculties at a time of large general progress, when hopes and ideas are apt to be extensive and vague.

But it is not enough that education should refrain from hindering the faculties of observation; it ought, if it is sound, actually to promote and enlarge those faculties. How this may be done is a problem not without difficulty. While the fault of inobservance is simple and single in its nature, the virtue of ready observation is complex, relating to many different spheres; he who possesses it in one sphere may lack it in another. When Thales, looking at the stars, tumbled into a well that lay before his feet, he was partly very inobservant,

partly very observant; by the one quality he doubtless incommoded himself grievously, by the other he discovered how to predict eclipses, saved mankind from a certain amount of irrational panic, and won for himself a great reputation. To Thales the balance was for good; but it would not be safe to affirm that this would be the case with every one who walked with his head in the air looking at the stars.

Thus the direction in which observation may be most usefully practiced varies with the circumstances of the case; with the circumstances of the pupil when education is in question; and is not the same in the different ranks of society. The problem has, we think, been most successfully solved at present in the colleges, more or less recently founded, of our great northern towns. There, physical science is in demand for practical purposes, and educational institutions accommodate themselves to the demand. But, in the elder universities and the elementary schools alike, an equal measure of solution has not yet been attained. Oxford and Cambridge students (to begin with the higher rank) have not, as a rule, any plain and visible necessity for physical science as an aid in their future employments. But there is another side of science besides the immediately practical one—a side which ought to be held of especial value in institutions that have under their survey the largest interests of humanity. The great sciences of observation—astronomy, geology, and the natural history of animals and plants—are more noticeable for their ideal than for their practical side, though they do touch on practice also. They give sublime views of the universe, such as it is a refreshment and consolation to possess, and such as touch not remotely on the destiny and happiness of man. We in England, at any rate, are not hopeless of the reconciliation of these views with the religious ideal that we have received. But it is the apparent collision, on certain points, between the new and the old that has impeded the reception of these sciences in those respects in which they are so calculated to elicit human feeling, and therefore so appropriate as studies in our elder and chief universities. In astronomy, indeed, the collision with religion has been long ago practically surmounted. But the observational side of astronomy has been rather sunk at Cambridge and Oxford in comparison with its mathematical side. It may be suspected that many students of astronomy (though not astronomers proper) have less knowledge of the actual face of the heavens than had those Chaldean shepherds who roamed the plains of the East thousands of years ago, in whom the science originated.

When we come to the poorer extreme of society, though the elementary education of the country does not quite ignore the cultivation of the observant faculties, neither does it, in our opinion, lay sufficient stress upon them. The arts of reading and writing, and the study of arithmetic, taken simply by themselves, have a tendency to withdraw the mind from the outer world, and it needs a corrective to restore

the balance. That corrective may, in certain cases, be supplied by the subject-matter of the books read, if it is required that they shall be intelligently understood. At the same time, such a requirement must be very positive and direct in order not to be evaded. Though the Education Department does at the present moment require from children in elementary schools, not merely an intelligent style of reading, but also (in the upper standards) an acquaintance with the subject-matter of the books read, it would naturally be felt to be extremely hard that a child should be declared to have failed in reading because he or she showed a want of proper observation. But we should like to see this whole topic of intelligent acquaintance with the subject-matter of the books read removed from the mere art of reading, and constituted into a separate subject by itself—say into a class subject, such as geography and grammar are now. If this were done, it would not be hard upon a child to demand from it some amount of observation as well as intelligence. If, for instance, the reading-book referred to any agricultural operation, such as harvesting, or to some well-known plant or flower or vegetable, or to cattle, or to birds, whether migratory or permanent in the country, then in a country school the children might fairly be questioned so as to bring out what they themselves had observed on these matters. In a town school questions might be asked on other matters to which reading-books would also now and then make reference—railways, stations, the different public buildings and their uses, the trades or manufactures specially practiced in the town. We can not but think that there is a real gap in the training of children in the poorer classes, and that the step we here recommend might do much to fill it.

It is true, and we note the fact with pleasure, that the Education Department has of late encouraged methods of teaching geography which bring out that side in which it is connected with direct observation. The suggestion that in every school the meridian line should be marked on the floor, in order that the points of the compass may be practically known, is a valuable one in this direction. Still more so is the suggestion, almost amounting to a requirement, that "good maps of the parish or immediate neighborhood in which the school is situated should be affixed to the walls." But of course the value of these appliances depends on the way in which they are used. The meridian line may be marked with exactness, the map of the parish may be unexceptionable, but if the knowledge of these points is not interwoven with the daily teaching it will be fruitless. And we can not but regret that the Education Department should treat geography as a subject inferior in importance to grammar. This is to place the abstract before the concrete, which is contrary to all natural and true method. We are sure that it needs far greater skill to render a grammar-lesson really fruitful and beneficial than to render a geography-lesson so. When grammar is made almost a necessity, while geogra-

phy is distinctly not a necessity, how is it possible but that geography must go to the wall? There is, indeed, another class subject recognized by the Education Department in their New Code which would cultivate observation even more, perhaps, than geography does—namely, elementary science. But we presume it is the opinion of the Department itself (as it certainly is our own) that this subject will not be largely used; for, in the recently issued "Instructions to Inspectors" it is passed over very cursorily, without the least indication as to the parts of natural science to be preferred, or any more than the vaguest as to methods. Elementary science will have a very uphill battle to fight if it is to win any real recognition, where the recognition of it involves the discarding of the more familiar geography, which by the terms of the Code it does. But our fear is that geography and elementary science will alike play but a poor part, in view of the superior importance and extended meaning given to grammar in the New Code. And, while some of the "specific subjects" of the Code are such as would encourage the observant faculties, these subjects are taken up by so small a number of children as hardly to affect the broad question we are discussing.

A suggestion, however, has been made which, if it could be carried out, would undoubtedly bring popular education into more direct relations with the external world, and therefore encourage the observant faculties more than is the case at present. This is that, just as girls are taught needle-work, so boys should in the course of their education be taught some elements of their future practical work in life. This has especially been urged in the interests of agriculture, and it has been thought that boys might be taught, while still at school, so much of the rudiments of farming as would greatly improve their future capacity. Of this proposal we can only say that we should be glad if it could be found practicable, but we are afraid the difficulties of connecting practical farming with school-work would be found very great. It might be easier to bring gardening into the school routine. But all that can here be said is that this suggestion, like all others that tend to relieve popular education from mere formalizing, deserves attention; and that, if the difficulties which it appears to present could be got over, it would certainly be a great benefit to the country.—*Saturday Review.*

SPECULATIVE ZOÖLOGY.

By Professor W. K. BROOKS,
of Johns Hopkins University.

II.

WE will now examine our various sources of information, in order to see how far the evidence which they furnish can be used to establish phylogenies.

Comparative anatomy might not at first sight be expected to yield much of this kind of evidence, for the only animals which we can study thoroughly are those recent ones which have diverged very widely from their remote ancestors; and, while it is true that the study of the structure of living animals does not furnish direct evidence, the doctrine of homology supplies a means of sifting out, by general comparisons, what has been recently acquired from what is more deep seated, and of thus arranging animals in a series of groups of greater and greater extent and less and less contact. This classification of animals upon morphological grounds is essentially phylogenetic, for the difference between a system of converging lines and a system of more and more inclusive definitions is simply a difference in the manner of expression; nor can it be said that the one method assumes the disputed point, genetic relationship, any more than the other, for the naturalist who believes that classification is not simply a matter of convenience, but that there is one natural system, and that, according to this system, living things fall into a few great groups, each of which is characterized by certain general features, and that each of these groups is divided into smaller groups distinguished in a similar way, and these again into smaller groups, and so on, tacitly assumes that the natural system of classification or relationship is what we should expect it to be if the theory of descent with modification is true.

If there is a natural "systematic classification," it must be exactly the same as a phylogenetic tree, and the idea of descent is no more essential in the one case than it is in the other; they are simply different ways of expressing the same thing, the relationship of living things, and neither of them involves more than the other any particular interpretation of the word relationship; nor can it be said that, while the one method assumes that the larger trunks of the system have at some time been embodied in actual organisms, the second method allows us to believe that these groups are purely ideal, for, although this latter conception may have been defensible to some extent in the early days of morphological science, the progress of discovery has shown that even nowadays animals exist in which the characteristics of a branch

or of a class or order are exhibited in their simplicity, and uncomplicated by the presence of the characteristics of any of the minor divisions of the group: thus amphioxus is a generalized or diagrammatic vertebrate, with structural features which are common to the whole group, and none of the distinctive marks of any of the great subdivisions of the group. In a phylogenetic tree such a form would be represented by a line running almost directly upward from a point where great branches diverge from a common stem; and the fact that these generalized forms are much more often found among fossil than among recent animals is very suggestive.

This short analysis is sufficient to show that the essential similarity between a system of classification based on homology and a phylogenetic tree is so great that all objections to the one method of generalizing from the facts must apply to the other. If phylogenetic speculations retard science, speculations upon homology must do the same thing, and the only way to avoid danger will be to stick to facts, and, stripping our science of all that renders it worthy of thinking men, to become mere observing machines.

As it is plain that the strictest construction of the proper scope and limits of scientific thought does not make any such demands as this, we may feel at liberty to speculate upon phylogeny with such a basis as is furnished by the comparative study of the systematic relationship of living animals, but we are not able to go very far in this direction, for nearly all living animals fall into a few great well-defined groups, and generalized types are the exception. Our conclusions must, therefore, be very vague and general, and we turn to the paleontological record for more exact data; but here, again, we soon meet with limitations which prevent any very exact and definite generalizations. One of these limitations, the imperfection of the record, we have already examined, and another is due to the fact that most of the main stems of the phylogenetic tree, and the minor branches of many of them, were established before the time of the oldest fossiliferous rocks, and we can not hope to find fossil remains of the unspecialized ancestors from which they were derived. This renders it hopeless for us to attempt actual proof of the more deep-seated phylogenetic relationships; and another consideration, which we will now examine, renders the discovery of the exact relationship of smaller groups of genera and species almost equally hopeless, even when the most ample series of fossils is discovered.

All that we know of variation indicates that it is not induced in the adult, but that it is congenital, and the effect of some force which has acted upon or through the parents. Hence it happens that, when a new variety is produced, it is not usually by the addition of something new to the characteristics of a mature animal, but by a divergence which shows itself before maturity is reached. When we compare two closely related species or varieties of birds, we do not find

that one is like the other with additions, but we find that the young are alike up to a certain point, where the divergence of the adults begins. If the letter A, in diagram 2, represents an adult animal, and the series of dots in the vertical line a few of the stages of its development between birth and maturity, the relationship between A and a closely allied species, B, would not usually be of such a kind that it could be expressed by the line A B, but by a line B *c*, running back to a younger stage of A. Since the duration of mature life is usually much longer than the period of development, adults are generally more numerous than young individuals, and, as their hard parts are in most cases more fully developed, there is a much greater chance of finding adult than young specimens of fossil species. Even if we should find in a recent geological formation the adult fossil ancestor A of a recent species B, the agreement between the two would be inexact, and could not be fully perceived until we had compared a number of stages in the development of B with corresponding stages in the development of A; and a reference to diagram 2 will show that the actual relationship of B to still another species, D, might be just as close as its relationship to A, although B might be much more different from D than from A. The complexity of the case would be still further increased if D were met with in a more recent stratum than that which yielded A, and in this case the preservation, discovery, and identification of three distinct sets of young forms would be necessary before the relationships of A, B, and D could be unraveled. In nature few cases are so simple as this, and, where a dozen species are involved, the complexity would be so great that no one who has had any practical acquaintance with the difficulty of identifying immature animals with certainty, without rearing them, could have any hope of complete, exact, and definite evidence of phylogeny from fossils.

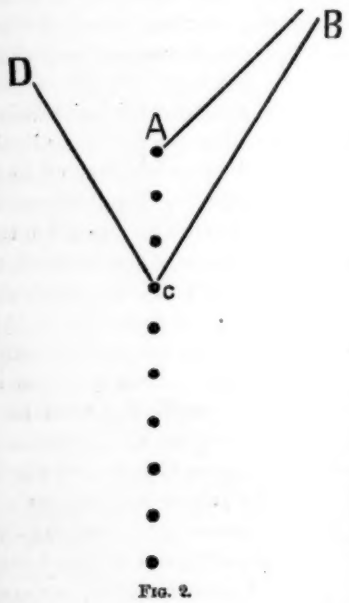


FIG. 2.

While this is true in every case, its truth is most obvious where animals have become adapted to new conditions of life, not by the acquisition of new specializations of structure, but by the loss of old ones. The occurrence of unquestionable cases of simplification, or what is usually called *degradation*, is well known to naturalists, but, as these cases are not so well known to the unscientific public as their signifi-

cance in any general theory of life demands, a short account of one of the less complex instances will not be out of place.

Entoconcha is an extremely simple, worm-like animal, which lives, as a parasite, inside the body of an holothurian. It is fastened, by a button-like head, into a perforation in the wall of the digestive tract of the holothurian in such a way that, while its mouth opens into the digestive cavity, its long, contorted body hangs in the body cavity of its host, so that it is bathed by its fluids, and protected by its body-wall. As the digested food passes by its mouth the animal sucks it into its rudimentary stomach, and, as all its wants are thus provided for, the conditions of its life are extremely simple, and its bodily structure exhibits a corresponding simplicity, and it may be described as a long, cylindrical, worm-like animal, with a simple, pouch-like stomach which opens by the mouth at the anterior end, and occupies about one half the length of the body, while the other half is filled by the equally simple organs of reproduction. It is as lowly organized as the simplest of parasitic worms, and it is only by a study of its development that we learn it is not a worm at all, but a gasteropod mollusk, which has become degraded or simplified to adapt it to a parasitic life. The ordinary gasteropods, the snails, conchs, etc., are animals of quite high organization. They are usually provided with a protecting shell, and their organs of locomotion are well developed. In connection with a specialized muscular system, they possess a well-marked and complex nervous system, as well as sense-organs, such as eyes, tentacles, and hearing organs. The digestive organs are quite highly specialized, and consist of parts which bear a close physiological resemblance to those of a vertebrate. The food is masticated by a very complicated system of jaws and teeth, and after it has been mixed with a secretion, which is poured into the mouth by salivary glands, it passes through a long muscular œsophagus into the stomach, where it is acted upon by fluids furnished by a liver and other glands, before it passes into the long, convoluted intestine, where the nutritive portions are absorbed into the blood, while the waste products are discharged from the body through the anus. The nutritive matter is driven to all parts of the body, with the blood, through a system of arteries and veins, by a pulsating heart, and during a part of its course the blood passes through respiratory organs, where it is aërated by contact with the air or water. The waste products are excreted from the blood by renal organs, and the organs of reproduction are extremely complicated and highly specialized.

The animal which has been seen to hatch from the egg of entoconcha is a young gasteropod, which, like the young of ordinary forms, has a spiral shell, a muscular locomotor foot, tentacles, eyes, hearing organs, and a nervous system like that of other gasteropods at the same stage of growth. The digestive tract is divided into regions, like those of an ordinary gasteropod, and the young entoconcha

has no peculiarities to indicate that the structure and habits of the adult are to be in any way strange or unusual; but after a time it finds its way, in some manner which has not been clearly made out, into the body of an holothurian, and this change in its habits is accompanied by a most marvelous change in its organization. It now has no shell, since the body-wall of its host affords ample protection, and, as it no longer needs to change its position in search of food, or to escape its enemies, its foot and specialized muscles have disappeared. Its organs of sense are wanting, and the nervous system is so rudimentary that no traces of it can be discovered. It has no need of organs to capture, masticate, or digest its food, since it sucks this, already digested, from the stomach of its host, and its digestive system has accordingly become reduced to a simple pouch, with only one opening—the mouth—and, as the whole surface of the body is bathed by the blood which is aërated in the respiratory organs of the holothurian, it has no need for gills, or heart, or blood-vessels, and, so far as our knowledge goes, these organs are entirely lacking.

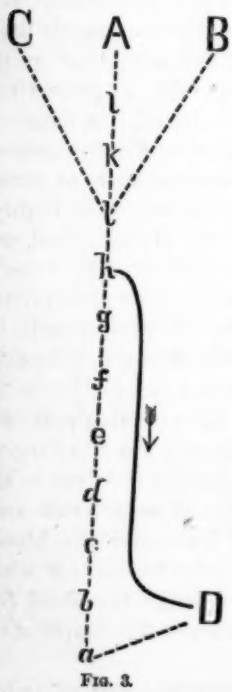


FIG. 3.

Of the highly specialized organs of a gasteropod only the simple stomach, the reproductive organs, and the slightly muscular body-wall remain, and no person who is not acquainted with the fact that young snails with spiral shells have been seen to come from its eggs would suspect that entoconcha is a mollusk.

Such cases, which modern research has proved to be by no means infrequent, show that the comparative study of adult animals can not furnish a complete key to their past history, and they also illustrate how little is to be hoped for from paleontology.

No one who accepts the doctrine of descent with modification, and is familiar with the embryology of the gasteropods, can doubt that, if we were able to trace back the pedigree of entoconcha, we should be led to a remote ancestor which was an ordinary gasteropod; not necessarily a species exactly like any we know, but a form with general gasteropod characteristics at least: nor can we doubt that, if we were able to study the embryology of this ancestral form, which we may represent by the letter A in diagram 3, we should find its life, from the egg to maturity, to be made up of a series of stages, *a*, *b*, *c*, *d*, *e*, *f*, etc., substantially like stages in the life of ordinary gasteropods, B and C. The relation between the entoconcha of the present day, D, and this gasteropod ancestor, is shown by the curved line to D. Start-

ing with the egg, the young entoconcha passes through a series of stages, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*, which are like stages in the development of an ordinary gasteropod, and therefore like stages in the life of its gasteropod ancestor, A; but, after reaching a certain point, it takes the back track shown by the unbroken line, and, gradually losing the structural complexity which has been acquired, becomes an adult, D, which has reproductive organs, but is, in other respects, as unspecialized as an ordinary gasteropod at one of its earliest embryonic stages, *b*.

It is obvious that paleontology can give us little help in tracing out such a life-history as this, and we turn to the remaining source of evidence, embryology, to examine how far the facts furnished by this department of life-science can afford a basis for phylogenetic generalizations.

The case which we have just examined shows that the embryology of two related forms may be essentially the same, since both of them have inherited the greater part of their life-history from a common parent, and it would seem at first sight as if all that we need, to enable us to trace out the relationship of all living animals, is a complete acquaintance with the embryology and metamorphosis of each one of them. A comparison of all the stages in the life of one species with all the stages in the life of another species of the same genus ought to show essential identity; and a comparison of the stages of development of the species of one genus with those of the species of a related genus ought to show how far their history has been the same: the common features in the embryology of two allied families should show how far the history of the species in one of them has been the same as that of the species in the other, and so on, each wider and wider comparison showing broader and broader relationships, until the features which are common to the embryos of all animals unite them into one great group.

As this may be clearer in a more abstract shape, I will try to state it in the form of a diagram (see Fig. 4).

Suppose that, in studying the development of four species, 1, 2, 3, 4, we find that 1 passes through a series of stages, *a*, *b*, *c*, *d*, *e*, *f*, *g*, *h*; that 2 presents the series *a*, *b*, *c*, *d*, *e*, *f*, *i*, *j*, *k*; while 3 passes through the stages *a*, *b*, *c*, *l*, *m*, *n*, *o*, *p*, *q*; and 4 through the stages *a*, *b*, *c*, *l*, *m*, *r*, *s*, *t*, *u*. A comparison of these four life-histories would indicate that their common relationships are such as are represented by the four-branched tree shown in Fig. 4. We have already seen that it is perfectly possible that *n* or *c* or *e* may not have been an adult animal, but simply a stage in the development of an unknown adult, *x*; so there would not be much chance of finding *m* or *e* or *c* as a fossil, and the embryonic record would not show us what the common ancestor of 1 and 2 or the more remote ancestor of all four species actually was, but would simply show that they are related in this way; but it would

show this relationship as conclusively as the vertebrate relationship of birds and mammals is shown by the presence of a backbone in each of them. It will be seen that the facts in this imaginary case belong to the same category with the facts of homology, but that they

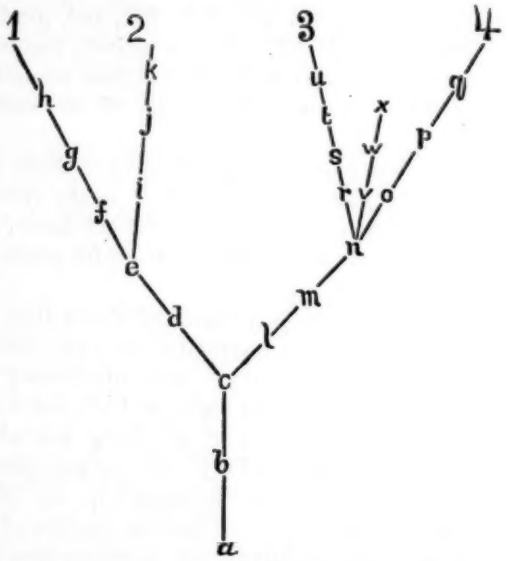


FIG. 4.

furnish a much more complete index of relationship, since they cover the whole life of the animal, instead of its adult form alone.

As a matter of fact we do find in nature something like this hypothetical case, and it is universally recognized that an acquaintance with all the stages in the growth of an animal is the greatest aid to the discovery of its true affinities; as is well shown by the case of entoconcha, and by the barnacles which were classed among the mollusca until a knowledge of their development showed that they are crustacea. When descriptive embryology was in its infancy, it so frequently happened that a knowledge of younger stages threw a flood of light upon the affinities of doubtful forms, that naturalists felt a growing hope that here was the true key to the natural system of classification, and that all they needed for reading the riddle was a thorough knowledge of the whole course of development of each form of life. If the embryology of each animal were a fixed quantity, this purely descriptive knowledge would undoubtedly furnish such a basis for phylogenetic generalizations; but the great advances which have been made in this field within the last twenty years show conclusively that this is not the case, but that the early stages in the life of an animal may undergo modifications which are quite independent of any which may meanwhile take place in the adult, so that, while the

paleontological record is faulty through incompleteness, that of embryology is faulty through distortion and secondary modification. In general we do find the young stages of related species more like each other than the adults, and the distinctive characteristics of each are usually acquired gradually during the process of development; but this rule is by no means universal, and there are very many cases in

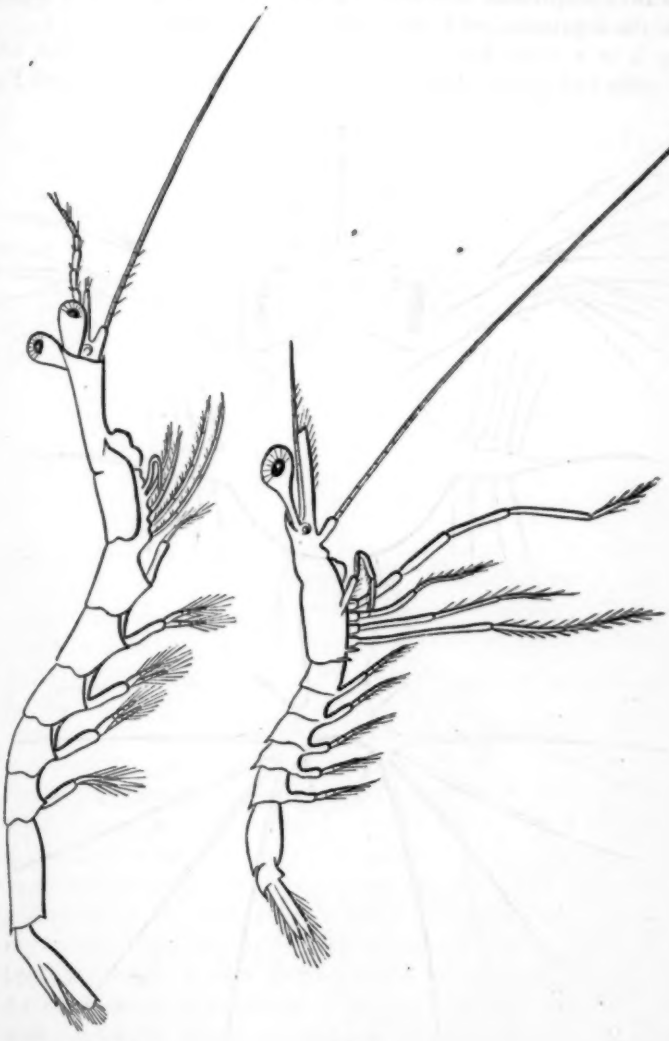


FIG. 6. FIG. 5.

which the adults of related species are more alike than the young, and in some cases the difference between the young forms is so great that their close relationship would hardly be suspected until each had been

traced to its adult form; and we have the converse of the case of entoconcha where the true affinities of a greatly modified adult are shown by its younger stages.

I give four figures to illustrate one such instance, which is not by any means exceptional or extreme; and in certain groups of animals, such as the crustacea, such cases are quite numerous.

Fig. 5 is a magnified side-view of a crustacean, Sergestes, which is not quite full grown, but still essentially like the adult; and Fig. 6

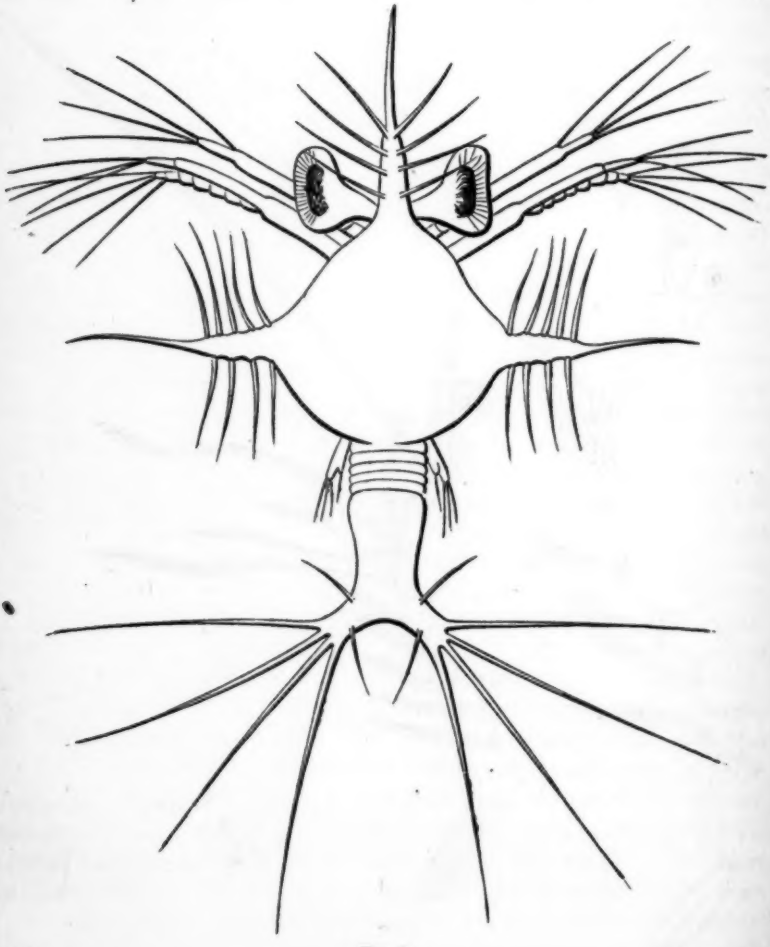


Fig. 7.

is a similar view of a closely related form, Lucifer, in a similar stage of development. Their close relationship is obvious at a glance, and their resemblances, which are much more conspicuous than their differences, are rendered more obvious by careful study; but the case is

quite different when the younger stages are compared, and at first sight no one would suspect that the Sergestes larva (Fig. 7) and the Lucifer larva (Fig. 8) are corresponding stages in the development of two animals as similar to each other as those shown in Figs. 5 and 6.

Not only do we find animals whose young stages differ more than the adults, but we also meet cases—and they are very numerous indeed—where the order of appearance of organs and features of the greatest taxonomic importance differs in the embryos of closely related forms.

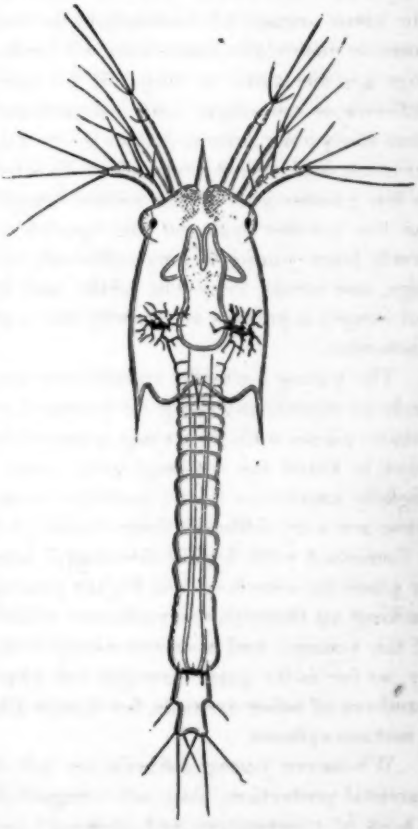


FIG. 8.

To take a particular instance, it is plain that, since the features which all the two-gilled cephalopods have in common, and which are characteristic of the group as a whole, must have been inherited from the common ancestor of the whole group, they ought, unless the embryonic history of the different recent species has undergone secondary modifications, to appear in the same order in the embryos of all the existing forms; and, if they do not, it is clear that descriptive embryology alone can not furnish a key to systematic affinity.

As a matter of fact, each one of the three species of two-gilled cephalopods with whose embryology we are most familiar differs from both the others in the order in which such significant organs as the arms, the shell, the eyes, the siphon, the gills, and the mouth make their appearance; and it must be obvious that, unless we have some means of analyzing these three life-histories, and determining which of them gives the true ancestral order, we can not make use of their embryology as a key to phylogeny. One who is not familiar with the whole field of life-science may fairly ask how it is possible to discover the relationships of animals from the study of their embryology if it is true that the early stages in the life of closely related species may differ so greatly, and if it is true that the order and manner in which structures make their appearance in the embryo are not

alike in all cases. Before answering this question, we must call the attention of the unscientific reader to a familiar fact which will throw great light upon the matter.

The animals with which we are most familiar, the mammals and birds, are born in substantially the form which they will have when they reach maturity. They breathe the same medium; they employ the same organs of locomotion, in the same way; they require the same or nearly the same kind of food, and their habits and surroundings are the same as they will be during mature life, or at least the differences are slight and insignificant, and the adult is little more than the young animal grown to its full size, and with sexual characteristics, and able to reproduce its kind. But we must recollect that, in the greater part of the animal kingdom, this is not the case. In by far the greater part of the species of animals the rule is that the newly born young is very different, in structure, in habits, surroundings, and needs, from the adult, and its passage to the adult form is not simply a process of growth, but a process of great change in every particular.

The young butterfly crawls over the plant on which it is born, and finds an abundant supply of proper food in the green leaves, which it cuts to pieces with its strong, scissor-like jaws. Its capacious digestive tract is fitted for dealing with great quantities of bulky but very slightly nutritious food; and its enemies, dangers, and means of defense are very different from those of the adult winged insect, which is furnished with highly developed sense-organs, and flies from place to place in search of the highly concentrated liquid food adapted for sucking up through the proboscis which has replaced the cutting jaws of the young; and we must recollect that the life-history of the butterfly, so far as its great changes are concerned, is a type of the life of numbers of other animals, for nearly all the invertebrates pass through a metamorphosis.

Whenever young animals are left to shift for themselves, without parental protection, they are compelled to struggle for existence with a host of competitors and enemies; and in all cases where the structure and habits of the young differ from those of the adult, a variation in the young animal may be as important for the welfare of the species as one in the adult, and may, therefore, be seized upon and perpetuated by natural selection, and in this way the young stages of two closely related species may be modified in different directions until they become quite different from each other, while the adults may remain essentially alike; and as natural selection may act in such a way as to modify the life-history of an organism at any stage of its existence, there is no limit to the secondary changes which may thus be brought about. A larva may acquire new organs, or it may lose old ones; the order in which organs are acquired may be modified; stages of development may be dropped out of the series, or new ones

may be added. A young form may become adapted to a new mode of life, or it may escape competition by seizing upon a new field; its enemies, dangers, and means of defense may change, and with these changes of habits corresponding changes of structure may occur, so that the primitive or ancestral record may become completely obscured by secondary changes.

The examination of the various kinds of modification which may be brought about in this way falls within the scope of a treatise on comparative embryology, but it would be out of place here, although one or two examples of the more common sorts of modification may be of interest.

The chrysalis stage of butterflies is an instance of the secondary acquisition of a new stage of development, which forms no part of the ancestral record.

It is obvious that the inactive pupa, which takes no food, and exhibits few of the ordinary activities of animal life, can not possibly have existed in the past as an adult ancestor of the butterflies, nor is it conceivable that any of the remote ancestry of this group bore a general resemblance to a pupa. While it is impossible to believe that the pupa stage is ancestral, we have good evidence to show the manner in which it has been acquired as a secondary modification.

Lubbock has pointed out that the least specialized or most primitive insects have mouth-parts which are indifferently adapted for either cutting or sucking, and that these insects do not undergo a metamorphosis, but are gradually converted into the adult form by a simple process of gradual development. He also shows good ground for believing that the common ancestors of all the groups of insects were like these forms in these particulars; and he holds that, as the stock which led to our present butterflies was evolved from this ancient stem-form, the young became adapted to a sedentary creeping life, and their indifferent mouth-parts became gradually converted into cutting jaws, while the adults became adapted to quite a different mode of life, and the same indifferent mouth-parts became gradually modified into a sucking proboscis. While the caterpillar and butterfly were thus diverging in two directions from the original unspecialized form, and the structure and habits of the larva were becoming more and more different from those of the adult, it is plain that the metamorphosis must at the same time have become more and more violent; and, according to Lubbock, one of the periods of slight activity which, in most insects, accompany the periodical molts, was seized upon, and gradually extended into a long resting or chrysalis stage, in order to enable the animal to exist while the highly specialized organs of the caterpillar are changing into the equally specialized but very different organs of the winged insect. The growing butterfly now passes through a resting or pupa stage which connects the

two periods of great specialization, and bridges over the gap between them, and thus does away with a period of imperfect specialization to both modes of life.

As an instance of the opposite kind of modification, the simplification of an embryonic history by the loss of ancestral stages, we may take the life of the fresh-water crawfish. Young lobsters, and most of the other marine allies of the crawfish, leave the egg in a form which is quite unlike the adult, in structure as well as in habits, and the new-born young pass through a long series of stages of metamorphosis before the mature form is reached.

The larval stages of the marine long-tailed crustacea bear such a resemblance to each other, and to certain lower crustacea, that we must regard them as ancestral; and we must therefore believe that they were one time present in the life-history of the crawfish, although we find nothing of the kind now. These larval forms are adapted to a swimming life at the surface of the ocean, and we can understand that, when the ancestors of the crawfishes became adapted to a life in fresh water, the larval stages must either have been modified to correspond or else been got rid of, and, in the crayfish, the latter has happened, and the new-born young is simply a very small image of the adult, the whole metamorphosis having been suppressed.

A person who is unfamiliar with morphology may fairly ask whether we are not entering upon treacherous ground, and why we are to regard the life-history of the lobster as the ancestral one, and that of the crawfish as a secondary modification, rather than the reverse. This feeling is not confined to unscientific thinkers, for many naturalists are inclined to reject this conception of the falsification of the embryonic record, and to say that, when we accept the evidence furnished by one species as a basis for phylogeny, and reject the evidence of a related species as of no taxonomic importance, we are actuated by mere caprice, or by a desire to establish some pet hypothesis, and that this method of reasoning can have no scientific value.

The most satisfactory answer to this objection would be a thorough analysis of a specific example, but this would involve technical comparisons and discussions which could not be adequately presented without a number of figures; and a sufficient answer for our present purpose may be found by a reference to the facts and conclusions of comparative anatomy.

A whale differs from all the ordinary mammals in quite a number of features in which it bears a close resemblance to fishes, and at the same time it differs from fishes in a number of points of resemblance to mammals. The attention of the earlier naturalists was attracted by the first set of resemblances and differences, and they placed the whale among the fishes; but later investigators have decided that the second set of resemblances alone give any evidence of systematic relationship, and that the whale is a mammal. Now, what

reason is there for regarding one set of resemblances as of taxonomic importance rather than the other? The answer is plain. It is easy to show that all the features in which a whale resembles fishes are such as we should expect to find if the whale is a mammal, adapted to an aquatic life; but the features of resemblance to an ordinary mammal do not admit of any such explanation, and they must therefore be held to indicate the true relationship.

If the crawfish originally passed through stages somewhat similar to those of the growing lobster, we can see why they may have been suppressed to adapt it to a life in fresh water; but, if the life-history of the crawfish is ancestral, we can find no reason, in the life of the lobster, for the acquisition of larval stages which are like those of more distantly related macroura, and, in rejecting one life-history and accepting the other, we are simply carrying the accepted principles of homological reasoning into wider fields, and applying them to a new class of phenomena; and a thorough acquaintance with the facts will render our conclusions as thoroughly scientific in the one case as in the other.

Those who are unfamiliar with the status of modern morphology are still accustomed to regard systematic zoölogy as a science of observation, but our review of the subject shows that the attempt to trace out the natural system of classification of animals carries us far beyond the bare facts, and that the observed phenomena, although practically infinite in numbers, bear about the same relation to the generalizations of the science that the facts of mathematics or of astronomy do to the general laws of these sciences.

The facts are so numerous and so difficult to observe, and our acquaintance with the conditions of life is so slight, that our attempts at general conclusions must frequently be tentative and provisional, and in some cases future research may show that they are entirely wrong; but this is no valid objection to the use of such evidence as we have. There is no more justice in the assumption that, because they may possibly be wrong, phylogenetic speculations upon the basis of paleontology, comparative anatomy, and embryology are adverse to the best interests of science, than there would be in the assumption that the attempt to trace the relationship of animals from the facts of homology is unscientific, because Cuvier thought that he had discovered homologies between the barnacles and mollusks, or because Agassiz associated the vorticellas with the polyzoa.

The end of phylogenetic speculation is perfectly legitimate, but we must rid our minds of the belief that it can be reached by mere observation and description. The evidence is often so hard to read that the accounts of the best observers are contradictory, and in many cases it is so scanty and incomplete that it must be submitted to a severely critical process of comparison, analysis, cross-examination, and elimination, before a general conclusion can be reached. The field is so vast,

the amount of evidence so great, and special features are so numerous, that the thorough discussion of the problem in all its bearings will furnish employment for the most acute and comprehensive powers of analysis for an indefinite period; but there is no reason to believe that the subject is beyond our grasp, or that it is not a perfectly proper field for intellectual activity.

We may fairly ask, though, whether, after all this is granted, it pays to spend our time in speculation upon circumstantial evidence, when all our conclusions may possibly be wrong, when they can not possibly be true unless they are put into a general form, and when the presumption in their favor is only a probability at best. Would it not be wise for us to spend all our time in the observation of nature, rather than to devote our energies to the discussion of general problems?

In matters where we are called upon to act we must weigh the probabilities, and form the best judgment we can according to our evidence; but this is necessary because we must act in any case, and it is no reason for carrying scientific thought into similar fields. In life it is often wise to act against the probabilities, as when an old man denies himself to make provision for a prolonged life, which he has very little chance of enjoying; but it does not follow that it is wise to form a scientific conclusion against the probabilities, and, if the analogy of actual life will not justify this, how can it justify a scientific conclusion which is based upon probabilities in the absence of demonstrative evidence?

If science were a pure abstraction, standing by itself, this objection might have weight; but no part of the phenomenal world does stand by itself, and nothing in nature is so independent of human interests that broader knowledge does not conduce to wiser judgments and actions: nor is the past history of life a remote subject, bearing so slightly upon human interests that it may properly be left to occupy the time and energy of future generations.

It has the same importance to us as living things that the history of the human race has to us as human beings. The future history of our race will be a continuation of the one line as well as of the other, or, rather, one is included by the other. The end of the study of history is not the discovery of what has been in the past, but the discovery of general laws and causes that shall enable us to foresee what is to take place in the future; but this sort of historical knowledge, the wisdom of history, does not come from observation, but from reflection upon the inner relations, the causes and effects of phenomena—from a weighing of the probabilities between one interpretation and another; and the wisdom which leads us to accept and act upon these probable conclusions, as the best available basis for the guidance of conduct, equally requires us to accept, in the same way, the results of the study of our prehistoric life-history. Our conclusions may be wrong, but,

so long as they are the best, we can not regard them as abstractions. We must welcome them as something more than knowledge—as an increase of wisdom in its widest sense.

If this justification of morphological speculation seems vague and indefinite, we need not seek far for more concrete reasons for encouraging this kind of thought, one of the most important features of which is its value as an intellectual discipline.

We can hardly overestimate the value of the power to reach logical conclusions, for this power is the basis of all wise conduct, and that education which aids in its acquisition has pre-eminent claims upon our attention. In almost every case where we are called upon to form a judgment, and to act upon it, the premises are so uncertain, the conditions of the problem so numerous and so little known, and its relations to other things admit of so much variation, that our conclusion can be nothing but a probability; and it is of the greatest importance that the mind should be trained in such a way as to fit it for forming wise judgments upon this class of complicated and indefinite problems.

Now, the questions which are presented for solution in the more exact physical sciences differ from the questions of morphology in the same way that they differ from the problems upon which we are constantly called to decide and act in ordinary life, but the degree of difference is less.

While the number of factors involved in a morphological problem is vastly greater than that of those which bear upon any problem into which life does not enter, and while the relations between these factors vary, in closely allied cases, in a way which has no parallel outside life-science, the problems of general morphology are still vastly simpler than those of society or of morality, or of almost any other department of human conduct, although they are like them in kind, and supply the same sort of evidence. The attempt to trace the mode of action of a constantly changing environment upon a form of life inheriting from an unknown series of ancestors a constitution that has been modified by a series of changes that can not be repeated, is no bad training for the attempt to foresee the working of a social reform that admits of no experiment, but must be tried once for all; which involves so many side-issues that no exact parallel to it can be found, and which is so complicated that it is impossible to foresee or follow out its results in detail.

The problems of the physical sciences are too definite and simple to afford much intellectual training in this most important field, and the problems of human life and society are too involved, too diversified, and too changeable to afford a proper field for studying the logical basis of our opinions; but in morphology we find what is needed, a field midway between the two.

The discipline which is to be obtained by the careful mastery of

such a work as Claus's speculation upon the origin of the crustacea, or by the critical study of the problem of the vertebrate skull, or by the study of the literature upon the affinity between the vertebrates and the annelids, is a better training in that logic of probabilities which is the basis of all conduct than can be found in the study of the other sciences; and from this point of view it is plain that good may result from honest but erroneous attempts at morphological speculation, for the logical restrictions of sound reasoning are often studied to the best advantage in the errors of acute thinkers.

PLAYAS AND PLAYA-LAKES.

By ISRAEL C. RUSSELL.

OF the many characteristic features of the arid region of the far West known as the Great Basin, none attract the attention of the traveler more forcibly than the desert mud-plains that have been left by the evaporation of former lakes.

These areas are known locally as mud-flats, salt-flats, salt-marshes, borax-flats, alkali-flats, deserts, sinks, etc., the name usually indicating some peculiar feature of the valley to which it is applied. As these desert regions have an almost identical history, the Spanish word *playa* —meaning *shore* or *strand*—has been adopted by geologists as a generic term under which the various desiccated lake-basins may be grouped. Valleys more absolutely desolate than the playas of the Great Basin can not be found, even in the midst of Sahara. They occur as mud-plains, occupying the lowest portion of arid valleys, and form a horizontal, even floor that is soft and perhaps covered by a shallow lake during the winter, but in the summer and fall becomes hard and dry, and crossed by innumerable shrinkage-cracks that give the whole broad surface the appearance of a tessellated pavement of cream-colored marble. At other times, after the water has evaporated, the salts contained in the mud of the playa are brought to the surface in solution by the action of capillary attraction, and a saline incrustation is formed on the surface of the desert when the water that held the salts in solution evaporates. In such instances the playa appears as white and dazzling as if covered with drifting snow. A journey across such a plain during the heat of summer, when the mirage renders even the most familiar land-marks uncertain, becomes the most weary and trying that the explorer is called upon to make.

Examples of playas of broad extent are furnished by the desert region that borders Great Salt Lake on the west, which was left as a vast mud-plain by the evaporation of Lake Bonneville. This is an absolute desert, more than a hundred miles long by thirty or forty

miles broad, composed principally of fine, tenacious, greenish clay. Other areas that now exist as great playas occur on the Carson Desert and on the Black Rock and Smoke Creek Deserts of Northwestern Nevada: these are portions of the bottom of Lake Lahontan that have been laid bare by the desiccation of the former lake. Playas of smaller extent, but which are yet typical examples of the deserts left by the withdrawal or evaporation of Quaternary lakes, are found in Diamond Valley, White-Pine Valley, Gabb's Valley, and Osobb Valley. All of these examples are in Nevada; but hundreds of others, of greater or less extent, might be enumerated that are scattered throughout the length and breadth of the Great Basin. As already mentioned, many of these playas are covered with water during the rainy season. Others exist as lakes, excepting when the season is unusually dry. They then become mud-flats that can not be distinguished from the playas that become dry and hard every summer.

The lakes that cover playas at certain times, and appear and disappear as the wet and dry seasons alternate, and are sometimes born of a single shower, and become many square miles in area during a single night, may with convenience be designated as *playa-lakes*, as they have many features peculiar to themselves. These lakes are without outlets, are seldom more than a few feet deep, and usually hold no more than a few inches of water; they are commonly alkaline or brackish, and are always, so far as the observations of the writer extend, of a peculiar yellowish or greenish-yellow color. The characteristic tint is due to the extremely fine mud, and probably chemical precipitates, that the waters hold in suspension. Owing to the extreme shallowness of these lakes, the fine mud at the bottom is agitated by every breeze, and thus the clearing of the water by the subsidence of the material held in suspension is prevented.

Playa-lakes, that form in the wet season and vanish again during the summer months, occur in a great number of the desert valleys and small inclosed basins to be found in the arid region between the Sierra Nevadas and the Wahsatch range. Some of these annual lakes are of considerable dimensions. On the northern part of the Black Rock Desert, Nevada, where Quin's River enters the desert from the northeast, a shallow lake is formed during the rainy season that is reported to be from ten to fifteen miles broad and as much as forty or fifty miles in length. When the dry season comes on, this lake evaporates, and the river that formed it shrinks back seventy-five or a hundred miles, leaving its channel a dry water-course, with perhaps a few water-holes to indicate its former extent.

Examples of playa-lakes that reach desiccation only during exceptionally dry seasons are furnished by Eagle Lake, Worth Carson Lake ("Carson and Humboldt Sink"), and Yellow-water Lake, in Nevada, and by Honey Lake and the lakes of Surprise Valley in California.

We have spoken of playas as being formed by the annual evapora-

tion of small lakes; others by the evaporation of lakes after a term of years when the season was unusually dry; there are also other playas that are only covered with water during exceptionally wet seasons. One might perhaps include in the list of playa-lakes the great lakes of the Quaternary, whose fluctuations extended through geological periods, and whose desiccation has left the largest of all the playas. Lake Bonneville and Lake Lahontan, however, can be called playa-lakes only during the closing chapters of their history; in the earlier portions of their existence, they were fresh-water lakes of great depth, and one of them, at least, overflowed.

When we examine the material composing playas more critically, we find that they are formed of at least two varieties of sediments. In the broad, open playas, like Great Salt Lake Desert and the two desert regions of the Lahontan Basin in Nevada, the surface is composed of soft, fine, greenish, saline clay, that is commonly saturated with alkaline water at a depth of a few feet, and becomes tenacious and difficult to handle. These clays are, without question, simply lake-beds that were deposited by sedimentation at the bottom of the great lakes that once occupied the valleys where they are found.

The second variety of playa-beds occurs in restricted basins and in valleys that are without outlets. These are found very commonly behind shore-bars of Lake Bonneville and Lake Lahontan, and in valleys and cañons the mouths of which have been crossed by the embankments of gravel built along the shores of these Quaternary lakes. The material forming playas of this nature is always of a light yellowish color, becoming almost white when dry; is extremely fine, and readily crumbles into dust between the fingers; near the surface, the beds are full of small globular vesicles that were apparently once filled with gas or water. These characteristics hold good even when the playas are surrounded on all sides by dark basalts, from the disintegration of which the playa-beds must have been formed.

True playa-beds, composed of light-colored material as described above, have been penetrated to the depth of five to six feet without revealing any change in the composition of the deposit. The thickness that may be reached by these slowly accumulating beds depends on the nature of the basin in which they are deposited; in some cases they can not be less than twenty or thirty feet in thickness. The coarse material swept down the sides of these inclosed basins by the infrequent rains is invariably left at the edge of the playa, and in a section of the beds appears as thin wedges of gravel and angular fragments, that thin out and become lost as we trace them away from the shore. Playa-beds may become covered with lake-beds, thus forming a peculiar light-colored stratum, in reality a fossil playa, that bears record of a time of desiccation; and, when lake-beds occur below, it is evidence that a dry period has intervened between two periods of more abundant precipitation.

The salts that form on the surfaces of playas are composed principally of the chloride, sulphate, and carbonate of soda, but sometimes contain borate of soda, sulphate of potash, sulphate of magnesia, and other salts in smaller proportion. In places the surface of a playa is sometimes formed of sulphate of soda several feet in thickness, as near the Buffalo Salt-Works on the Smoke Creek Desert, Nevada. Again, crystals of sulphate of lime (selenite), forming a bed more than six feet thick, cover hundreds of acres of the playa-surface, as on the eastern border of the Sevier Desert in Utah. Sometimes a playa for many square miles in extent is covered by a layer of salt a few inches in thickness, as was the case when Sevier Lake in Utah evaporated to dryness a few years since, and as is shown also by the large salt-field in Osobb Valley, Nevada. At other times the beds composing the playa contain brine beneath the surface, which yields large quantities of nearly pure salt upon evaporation; the supply of salt from this source in Nevada is practically without limit.

When by a change of climate a playa is no longer flooded, the subaërial gravels that are constantly moving down toward the bottom of a valley eventually overflow the entire surface of the playa, and the valley acquires a rounded instead of a horizontal floor. The same action tends to obliterate the beach-marks that a lake makes along its shores, so that in time all records that a lake has once occupied a valley become buried and erased: where once a broad, clear lake existed in which glacial covered peaks were reflected, there now stretches an arid desert, bearing only a scanty growth of artemisia. This, in brief, is the history of a large number of the valleys of the Great Basin.

SCIENTIFIC FARMING AT ROTHAMSTED.

By MANLY MILES, M. D.

II.

THE primary and leading object of the experiments with animals, which have been conducted at Rothamsted during the past thirty-five years, was the solution of practical agricultural problems; but, as in the case of the field experiments already noticed, the practical lines of inquiry have naturally led to the investigation of a wide range of topics belonging to the science of biology, which, in themselves, are of more particular interest to the physiologist, or even to the student of sanitary or of social science, than to the farmer.

From the number of animals under experiment, and the well-planned and thorough methods of investigation, in all departments of the experimental work, the results obtained have been of great value,

not only from the light thrown on many of the obscure processes of nutrition, but also in laying a foundation for a consistent system of feeding, in which the relations of the food consumed to the special animal products obtained, and to the value of the manure produced, as an incident of the process, are clearly traced.

In determining the amount of food and of its several constituents consumed for a given live weight of the animal in a given time, and the amount of food and of its several constituents required to produce a given amount of increase in live weight, several hundred animals, including oxen, sheep, and pigs, were subjected to experiment. In these researches, selected lots of animals were supplied, for weeks or months, with weighed quantities of food of known composition, as determined by analysis, and especially adapted to the particular point under investigation. The animals were weighed at the beginning, at intervals during the progress, and at the close of the experiment.

The composition of the manure produced from a given amount and quality of food consumed, by oxen, sheep, and pigs, was determined in a large number of cases by analyzing average samples of the food, and then making an analysis of the solid and liquid excretions of the animals. In these experiments, the oxen were fed in boxes in which the manure was preserved with litter of known composition. After feeding for from five to nine weeks, the total manure produced was carefully mixed, weighed, sampled, and analyzed. By this method the solid and the liquid excreta were not separately examined. With sheep no litter was used, the animals, in lots of five, being fed on a slatted platform with an inclined floor of sheet-zinc below it, so that the urine was drained into carboys containing acid, while the solid excretions were separately removed several times a day and preserved for analysis. The constituents determined in the food and in the manure in the experiments with oxen and sheep were dry matter, mineral constituents, and nitrogen, and in some cases woody fiber. As an illustration of some of the difficulties that must be overcome in making exact investigations of this kind, a more particular description of some of the devices resorted to will be of interest. "In the case of pigs, individual male animals were experimented upon, each for periods of three, five, or ten days only. Each animal was kept in a frame, which prevented it from turning around, and having a zinc bottom, with an outlet for the liquid to run into a bottle, and it was watched night and day, and the voidings carefully collected as soon as passed, which could easily be done, as the animal never passed either fæces or urine without getting up, and in getting up he rang a bell and so attracted the notice of the attendant. The constituents determined were, in the food and fæces, dry matter, ash, and nitrogen, and in the urine, dry matter, ash, nitrogen, and urea."

The amount and relative proportion of the different organs and parts of the body were determined in two hundred and forty-nine

sheep, fifty-nine pigs, two calves, two heifers, and fourteen bullocks. As the object of this investigation was to obtain average data as to the proportions of the valuable carcass parts and the less valuable offal parts, in animals in different conditions as to fatness, a variety of animals were examined. The sheep under experiment may be grouped as follows: five sheep of different breeds in the lean or store condition; one hundred sheep of different breeds moderately fattened; forty-five sheep of different breeds excessively fattened; seventy-eight Hants Down sheep moderately fattened on different foods; and twenty-one sheep of different breeds and modes of feeding of more than average fatness. The fifty-nine pigs were moderately fattened on a variety of fattening foods.

The percentage weights of the different parts of the body of the three classes of animals, and of the sheep in the store, the fat, and the very fat condition, are given in the following condensed table from Dr. Lawes's lecture before the Royal Dublin Society:

PARTS OF THE BODY.	Average of 16 oxen.	Average of 240 sheep.	Average of 59 pigs.	Average of 5 store sheep.	Average of 100 fat sheep.	Average of 45 very fat sheep.
Stomachs and contents	11·6	7·5	1·3	9·1	7·0	5·6
Intestines and contents	2·7	3·6	6·2	5·3	3·8	2·8
	14·3	11.1	7·5	14·4	10·8	8·4
Internal loose fat	4·6	6·9	1·6	4·5	6·0	7·5
Heart, aorta, lungs, windpipe, liver and gall-bladder, with contents, spleen, pancreas, and blood	7·0	7·3	6·6	8·4	7·7	6·5
Other offal parts	13·0	15·0	1·0	17·9	16·1	13·1
Total offal parts	38·9	40·3	16·7	45·2	40·6	35·5
Carcass	59·3	59·2	82·6	53.4	58·7	64·1
Loss by evaporation, etc	1·8	0·5	0·7	1·4	0·7	0·4
Total	100·0	100·0	100·0	100·0	100·0	100 0

It will be seen that the stomach and contents make up 11·6 per cent of the live weight of the oxen, 7·5 per cent of the live weight of the sheep, and but 1·3 per cent of the live weight of the pigs, while the intestines and contents rank in the inverse order, giving the highest percentage in pigs and the least with the oxen. If the stomachs and intestines are taken together, we find the highest percentage in the oxen and the least percentage in the pigs. These figures correspond very closely to the relative amount of work required in the digestion of the food of the different animals, which is coarse and more bulky in the case of the oxen, and comparatively concentrated and of higher nutritive value in the case of the pigs. The greater relative development of the intestines in pigs has a probable relation to the more complete assimilation of the food of these animals. As a whole, the glandular and circulatory organs, which are grouped together in the table, are nearly in the same proportion in the three groups of

animals, the range of variation being but little more than one half of one per cent. It should be stated that the much smaller percentage of offal parts, and the corresponding larger percentage of carcass, in the pigs, is partly to be attributed to the head and legs being included with the carcass of the pigs, while they are reckoned as offal parts in oxen and sheep. With sheep there was a rapid decrease in the percentage of offal parts as the animals fattened, while the percentage of carcass increased from 53·4 in the store condition to 64·1 in the very fat condition. There was, however, an actual increase in the offal parts from the store to the very fat condition in the proportion of one to one and three quarters, but the carcass parts made a greater actual increase, one pound in the store condition being raised to two and one half pounds in the very fat condition.

In connection with the data furnished by the mass of facts relating to the relative proportion of organs and parts of the body, which we can not discuss in detail, it became a matter of interest to ascertain the chemical composition of the increase of fattening animals obtained from different articles of food, so that the relations of the food constituents to the constituents of the increase could be determined. As a chemical analysis of a living animal can not be made, it is of course impossible to determine directly the chemical composition of the increase, as an analysis would be required at the beginning and at the close of the fattening period. The composition of the increase of fattening animals must therefore be determined by indirect methods, as by calculation from the data furnished by the differences in the composition of the food and the excretions; or from assumed constants, in the form of averages obtained by analyzing a large number of representative animals.

The most satisfactory data relating to this subject, that have ever been published, will be found in the results of the numerous analyses of the entire bodies and parts of animals, in different conditions as to fatness, that have been conducted at Rothamsted. Determinations were made of the fat, nitrogenous substance, and mineral matter of the entire body, and of certain separated parts, of ten animals, described as follows: 1. A fat calf, of the shorthorn breed, nine or ten weeks old, taken from its dam, feeding on grass; 2. A half-fat Aberdeenshire ox, about four years old, fed on fattening food, but which had grown rather than fattened; 3. A moderately fat Aberdeenshire ox, about four years old; 4. A fat Hampshire Down lamb, about six months old; 5. A Hampshire Down store sheep, about one year old; 6. A half-fat Hampshire Down ewe, three and one fourth years old; 7. A fat Hampshire Down sheep, one and a fourth year old; 8. A very fat Hampshire Down sheep, one and three fourths year old; 9. A store pig; 10. A fat pig. The pigs were of the same litter, and, when selected, were as nearly as possible alike, one weighing one hundred pounds and the other one hundred and three pounds. "One was

slaughtered at once, and its contents of nitrogenous substance, fat, mineral matter, etc., accurately determined. The other was fed on a mixture consisting of bean-meal, lentil-meal, and bran, each one part, and barley-meal three parts, given *ad libitum*, but accurately weighed, for a period of ten weeks, when it had nearly doubled its weight. The animal was then slaughtered, and analyzed as the other had been. The composition of the food was also determined by analysis."

According to the generally accepted theory of nutrition at the time the Rothamsted feeding experiments were planned, the constituents of foods were divided into two leading groups, each of which was assumed to serve a special purpose in the system. It was believed that the nitrogenous constituents were the only nutritive elements, and that the carbonaceous constituents (including the fat, starch, etc.) served as fuel, which was burned in the system to keep up the animal heat. In the published analyses of animals and of foods at Rothamsted, this distinction was recognized, and the results are given in terms of these groups of constituents. A summary of the results of the analyses of the ten animals described above is given in the following table, in percentage values of groups of constituents, in the carcass and in the total offal parts:

ANIMALS.	Mineral matter (ash).		Nitrogenous substance (dry).		Fat (dry).		Total dry substance.		Water.	
	In carcass.	In offal.	In carcass.	In offal.	In carcass.	In offal.	In carcass.	In offal.	In carcass.	In offal.
Fat calf	4·48	3·41	16·6	17·1	16·6	14·6	37·7	35·1	62·3	64·9
Half-fat ox	5·56	4·05	17·8	20·6	22·6	15·7	46·0	40·4	54·0	59·6
Fat ox	4·56	3·40	15·0	17·5	34·8	26·3	54·4	47·2	45·6	52·8
Fat lamb	3·63	2·45	10·9	18·9	36·9	20·1	51·4	41·5	48·6	58·5
Store sheep	4·36	2·19	14·5	18·0	23·8	16·1	42·7	36·3	57·3	63·7
Half-fat old sheep	4·13	2·72	14·9	17·7	31·3	18·5	50·3	38·9	49·7	61·1
Fat sheep	3·45	2·32	11·5	16·1	45·4	26·4	60·3	44·8	39·7	55·2
Extra-fat sheep	2·77	3·64	9·1	16·8	55·1	34·5	67·0	54·9	33·0	45·1
Store pig	2·57	3·07	14·0	14·0	28·1	15·0	44·7	32·1	55·3	67·9
Fat pig	1·40	2·97	10·5	14·8	49·5	22·8	61·4	40·6	38·6	59·4
Means of all	3·69	3·02	13·5	17·2	34·4	21·0	51·6	41·2	48·4	58·8

This table furnishes some important data for an intelligible discussion of the economics of nutrition, with reference to human dietaries, but there are many points of interest presented in the details of the analyses of these animals that can not be embraced in such a tabular abstract. In the carcass of the fat calf, it will be noticed, the percentage of nitrogenous substance and of fat is the same, while in the other animals the fat is largely in excess, even in those in store condition. There is likewise a larger percentage of nitrogenous substance in the offal parts than in the carcass in all cases. It was also found that "the fat of the bones bears but a small proportion to that of the whole carcass, while, of the whole of the nitrogen of the carcasses, perhaps not less than one fifth will be in the bones. . . . As the animal

matures, the mineral, the nitrogenous, and the fatty matters all increase in actual amount; but the percentage of both mineral matter and nitrogenous substance decreases, while that of the fat increases so as to much more than compensate for the decrease in that of the other solid matters. The result is that there is an increase in the percentage of total dry substance." The young animals, as the lamb and calf, had a larger proportion of water in the carcass than other animals in the same condition; and there was a larger proportion of bones in the carcass of the calf than in the carcass of the other animals.

In estimating the composition of the increase in live weight of fattening animals it was assumed that the composition of the original weight, that is, the weight at the beginning of the feeding period, was the same as in the "store" or "half-fat" animals that had been analyzed; and that the composition of the animal at the close of the feeding period was the same as that of the "fat" or the "very fat" animal that had been analyzed. By a proper exercise of judgment as to the comparative condition and quality of the animals at the beginning and end of the feeding period, and applying the data derived from the analysis of animals of similar quality, a close approximation to the composition of the increase could thus be obtained, and the probable error would be reduced to a minimum when the averages were made up from a large number of animals. In this way the composition of the increase was estimated in the case of ninety-eight fattening oxen, three hundred and forty-nine fattening sheep, and eighty fattening pigs, divided into numerous classes according to breed, condition of maturity, and description of food consumed. The estimated average percentage of mineral matters, nitrogenous substance, fat, and total dry substance, in the increase of these animals, is given in the following table:

ANIMALS.	Mineral matter (ash).	Dry nitrogenous substance.	Fat.	Total dry substance.
98 oxen—average.....	1·47	7·09	66·2	75·4
349 sheep "	2·34	7·13	70·4	79·9
80 pigs "	0·06	6·44	71·5	78·0
The analyzed fat pig.....	0·53	7·76	63·1	71·4
Means.....	1·10	7·26	67·8	76·2

The averages of all the animals under experiment, fed under a variety of conditions, and including the "fat" and the "very fat," are here given. In the tables which follow, however, data from selected cases are made use of, which do not change the general results, but represent, it is believed, more nearly, the results obtained in ordinary farm practice.

The percentage of mineral constituents in the increase of the sheep as given in the table is undoubtedly too high, from the presence of foreign matters in the wool which could not well be separated; this

will of course affect the percentage of total dry substance which is the sum of the figures given in the three preceding columns.

We may now consider the relations of the constituents of the food to the constituents stored up in the increase. In the experiments to determine the amount of food and of its several constituents, consumed by an animal of given weight within a given time, and required to produce a given increase in live weight, the foods presented a wide range of variation in composition, and the rations were so planned that the animals had a supply of *ad libitum* food containing more or less nitrogenous substance, that enabled them practically to fix for themselves the relative proportions of the nitrogenous and non-nitrogenous constituents consumed. In all of the feeding experiments it was found that the amount of food consumed by a given live weight of the animal, within a given time, and also the increase in live weight obtained from it, depended more upon the non-nitrogenous constituents, or even on the total dry substance, than upon the nitrogenous constituents, which had been generally assumed to be the true measure of nutritive value. In experiments with animals expending their energies in the form of work, the same demand for the non-nitrogenous constituents of the food was observed as in the case of fattening animals. A certain moderate amount of nitrogenous substances was evidently needed in the food, but any increase beyond this required quantity had no influence upon the returns obtained for food consumed, either in the form of muscular force in working animals, or in increase in live weight in those that were fattened, or even on the amount of nitrogen contained in such increase. The nitrogen discharged in the urine, in the form of urea, was found to have no relation to the activity of the muscles, but it was directly increased by an increment of nitrogenous materials in the food. The age and habits of the animals themselves, when growing or fattening, seemed, however, to determine, to some extent, the proportions of nitrogenous materials in the stored-up increase.

The average results show that oxen supplied liberally with food of good quality, containing a moderate proportion of grain or other concentrated food, would consume at the rate of from twelve to thirteen pounds of dry substance * per week for each hundred pounds of their weight, and that one pound of increase in live weight would be returned for it. Sheep, of several different breeds, consumed, on the average, about fifteen or sixteen pounds of dry substance of slightly better food per week for each hundred pounds of live weight, and returned about one pound of increase in weight for each nine pounds of dry substance in their food. Pigs, with food composed largely of

* Cattle-foods differ widely in the amount of contained water; the average being in hay from ten to fifteen per cent, in grain from eight to fifteen per cent, and in roots from seventy-five to ninety per cent. The strictly "dry substance," excluding this variable element of water contents, is therefore taken as a basis in estimating nutritive values.

grain, consumed from twenty-six to thirty pounds of dry substance per week, for each hundred pounds of live weight, and yielded one pound of increase in weight for each four or five pounds of dry substance in their food. Oxen, therefore, consume more dry substance of food, in proportion to their weight, than sheep, and sheep consume more than pigs, while, in return for feed consumed, pigs yield more than sheep, and sheep gave better results than oxen. It must be remembered in this connection, as has already been pointed out, that the food of oxen contained more woody fiber, while that of the pigs was comparatively concentrated and digestible, and therefore of better quality. With sheep of different breeds it was found that, under the same conditions as to age and fatness, the food consumed was in proportion to their live weight. The relative value of the larger and smaller breeds seems, therefore, to depend, to a great extent at least, upon their habits and hardiness, and their adaptation to the conditions of the locality in which they are placed.

In studying these experiments, it will be well to keep in mind the twofold function of food in the animal economy: first, as the source of energy for the performance of work in the various organs of the body, which is required in elaborating the peculiar animal products sought in the process of feeding (as milk, flesh, wool, etc.), and in carrying on the processes of repair and reconstruction to maintain the integrity of the animal machinery; and, in the second place, as supplying the materials for the construction or elaboration of the special animal products. The popular notions of nutrition assume that this supply of materials in the food for the new product sought is the most important, and the supply of energy for the performance of work is overlooked or assigned a subordinate position.

The results of the experiments relating to the use and ultimate disposition of the food consumed by animals when fattened under average conditions, as to feed and increase, are given in the following table:

ANIMALS.	Each 100 pounds of dry substance in the food consumed was disposed of as follows:		
	Stored up as increase.	In manure.	Used in internal work of the system, and not accounted for in manure or increase.
Oxen	6·2	36·5	57·3
Sheep	8·0	31·9	60·1
Pigs	17·6	16·7	65·7

The figures in the last column of the table are not intended to represent all of the internal work of the system. They simply show the amount of non-nitrogenous constituents that are not accounted for in the stored-up increase, or in the manure, and thus are properly designated as having been used in internal work. From an agricultural stand-point, the proportions of food-constituents stored up as increase,

and voided as manure, are of the first importance, as these are the two factors that determine the economy of feeding. The expenditure of energy in the system, from the nitrogenous constituents of the food, is not, therefore, included in the last column, as all of the nitrogen of the food that is not stored up as increase is finally excreted in the urine. The first and second columns of the table, therefore, include the nitrogenous and the mineral substances of the food, and any energy that may have been expended as a result of their metamorphoses is not represented in the table.

From the data presented, it appears that more than one half (57·3 per cent) of the food of oxen when fattening is required in internal work, or in keeping the animal machinery in repair, to say nothing of the energy expended by the nitrogenous constituents, while but 6·2 per cent is stored up as increase in weight, and more than one third is found in the manure. With sheep, 8·0 per cent of the food is stored up as increase, less than one third appears in the manure, and 60·1 per cent is used in work of the system. The pigs give 17·6 per cent of the food in increase, or more than twice as much as the sheep, while nearly two thirds is required for internal work, and the manure contains less than one half as much as in the case of the oxen. The pigs store up a much larger proportion of their food as increase than either the sheep or the oxen, but a larger percentage is used in internal work, and less appears in the manure. The increased expenditure in work would naturally follow from the larger amount stored up as increase, which involves as a matter of course an expenditure of energy in its elaboration. But this is not the whole truth, as will be seen on making a comparison of the figures in the first and last columns of the table. For a given amount of increase stored up, the oxen actually expend more in internal work than sheep, and the sheep expend more than the pigs It evidently costs more, in internal work of the system, to elaborate the stored-up increase from the crude feed of the oxen than from the more nutritive food of the pigs. When the facts are examined from a different stand-point, the relations of the increase to work of the system will be more clearly seen, as in the following table, which gives the results obtained from a given live weight of the animals in a given time :

ANIMALS.	For each 100 pounds of live weight, per week.				
		Dry substance.			
	Stored as increase.	Consumed in food.	Recovered in manure.	Used in internal work of the system, and not accounted for in manure and increase.	Used in internal work for each one pound of stored increase.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Oxen.....	1·13	12·5	4·56	7·16	6·34
Sheep.....	1·76	16·0	5.10	9·62	5·47
Pigs	6·43	27·0	4·51	17·74	2·76

The oxen make in increase but little more than one per cent of their weight per week, the sheep make one and three fourths per cent, and the pigs nearly six and one half per cent of their weight per week. Nearly the same amount of dry substance of the food appears in the manure of the different animals per week for each hundred pounds of their live weight. In proportion to their weight, the pigs consume more food, and a larger amount of food-constituents is actually used in work of the system, but, from the greater rate of increase, the work required to produce a pound of increase is less than one half of that required in oxen. These facts are of particular interest in connection with the differences already noticed (page 384), in the relative percentage weights of the digestive organs of oxen, sheep, and pigs.

The dry substance of the food has alone been taken into the account in the preceding table, but, if we trace the final disposition of its several constituents in the system, we shall find marked differences in the proportions of each that are stored up as increase, voided in manure, or used in work of the system. The percentage of each group of food-constituents stored up as increase and voided in the manure is given in the next table:

CONSTITUENTS OF FOOD.	Each 100 pounds of food-constituents consumed was disposed of as follows:					
	Stored up in increase.			Voided in manure.		
	Oxen.	Sheep.	Pigs.	Oxen.	Sheep.	Pigs.
Nitrogenous substance.....	4·1	4·2	13·5	95·9	95·8	86·5
Non-nitrogenous substance....	7·2	9·4	18·5	14·1	8·9	4·1
Mineral matters.....	1·9	3·1	7·3	98·0	97·0	92·7

The nitrogenous substance and mineral matters, as will be seen, are all accounted for in the stored-up increase and the manure, but there remains from 77·4 to 81·7 per cent of the non-nitrogenous substances that can not be found in the increase of the body or in the residual manurial excretions, as they have been used in internal work and excreted in the process of respiration.

Sheep store up as increase a larger proportion of all the food-constituents than oxen, and pigs store up a much larger proportion than sheep. The percentage of nitrogenous constituents stored up as increase or voided as manure will vary widely with different foods. We have seen, as a result of these experiments, that but a small proportion of nitrogenous substance was required in the food, and that the needed amount was comparatively constant under varying conditions. If the food contains but a moderate amount of nitrogenous substance, a larger percentage of it will be required by the system, and the amount appearing in the manure will be so much diminished; but with highly nitrogenous foods a small percentage of the nitrogenous constituents will suffice for the purposes of the system, and the excess will appear in the manure.

Among the many important results obtained in the experiments at Rothamsted, the data furnished for estimating the relative value of barn-yard manures are of particular interest. The essential constituents of barn-yard manure, or those having a commercial value, are nitrogen, potash, and phosphoric acid, which are of course derived from the feed consumed by the animals making the manure. The composition of the food being known, the percentage of its several constituents that are voided in the manure may be estimated from the data obtained in these experiments, so that the relative value of the manure produced from different articles of food can be determined with sufficient accuracy for all practical purposes. From the results of the Rothamsted feeding experiments, we can not avoid the conclusion that the cereal grains and the highly nitrogenous linseed and cotton-seed cakes have essentially the same value as fattening foods, and that there is but little, if any, difference in the feeding value of timothy and clover hay. When the production of manure is concerned, however, the clover has a much higher value than timothy, and the linseed and cotton-seed cakes are worth very much more than the cereal grains. That is to say, the digestible and available non-nitrogenous constituents of the food determine its nutritive value, provided always the moderate required supply of nitrogenous materials is present, and the comparative manurial value is determined by the nitrogenous constituents. A variety in the ration would undoubtedly be desirable for nutritive purposes, as the best results can not be obtained with any single article of diet.

From the facts already presented it appears that a large proportion of the increase of fattening animals, in many cases more than two thirds, is fat. It was formerly supposed that the fat of animals was derived from the fatty materials in the food, but this source was found to be entirely inadequate. The non-nitrogenous constituents of the food—the carbo-hydrates—were then quite naturally looked upon as the source from which the fat was elaborated; but afterward Professors Voit and Pettenkofer insisted that the fat of animals was almost exclusively formed from the nitrogenous constituents of the food. In experiments with pigs, which are evidently the most suitable animals for experiments relating to the formation of fat, Drs. Lawes and Gilbert conclusively show that, with foods in which the ratio of the nitrogenous to the non-nitrogenous constituents was a suitable one for fattening purposes—as in Indian corn and barley—a large proportion of the fat in the stored-up increase must have been produced at the expense of the non-nitrogenous constituents. There was also evidence that the nitrogenous constituents of the food, when in excess, might replace the carbo-hydrates, to some extent, in the formation of fat.

The analysis of the entire bodies and parts of the ten animals made at Rothamsted furnish some interesting data in regard to the compo-

sition of the animal food consumed by man. It has been generally assumed that the effect of animal food, in human dietaries, is to increase the proportion of the nitrogenous constituents: from the results of these analyses, however, we can not escape the conclusion that the animal elements of a diet, as a whole, increase the proportions of the carbo-hydrates or non-nitrogenous constituents. It appears that two thirds of the nitrogen of the entire body, of the calf and bullocks, was found in the carcass, and of this twelve parts were in the bones, leaving fifty-four per cent of the whole nitrogen of the body in the soft parts of the carcass. Of the thirty-three per cent of the nitrogen of the entire body in the offal parts, it was estimated that in the calf seven to eight parts, and in the oxen four to five parts, would be consumed as human food. Of the total fat of the body, about seventy per cent in the calf, and rather more than seventy-five per cent in the oxen, were found in the carcass. Of the fat contained in the offal parts, it was estimated that five sixths in the calf and one fifth in the oxen would be consumed as human food. The percentage of the total nitrogenous and total non-nitrogenous constituents of animals, included in the food of man, has been tabulated by Drs. Lawes and Gilbert as follows:

ANIMALS.	Per cent consumed as human food.	
	Of the total nitrogenous compounds of the body.	Of the total fat of the body.
Calves	60	95
Oxen	60	80
Lambs	50	95
Sheep	50	75
Pigs	78	90

According to this estimate, "there would be, in the fat calf analyzed, 1½ time, in the fat ox 2¾ times, in the fat lamb, fat sheep, and fat pig nearly 4½ times, and in the very fat sheep 6¼ times as much dry fat as dry nitrogenous constituents" in the parts of the animals consumed as human food. As one part of fat is equivalent to two and one half parts of starch, as a source of potential energy which must be taken as the measure of nutritive value, it will be necessary to estimate the fat in its equivalent as starch in making a comparison of vegetable and animal foods with reference to their nutritive value, and the relative ratio of their nitrogenous and non-nitrogenous constituents. On this basis the results of the Rothamsted analyses have been tabulated as follows:

RATIOS.

DESCRIPTION OF ANIMALS.	Proportion of dry fat to 1 of dry nitrogenous compounds.		Proportion of starch-equivalent of fat to 1 of dry nitrogenous compounds.	
	In carcasses, including bone.	In estimated consumed portions of the animals.	In carcasses, including bone.	In estimated consumed portions of the animals.
Store, lean and half-fat animals:				
Store sheep	1·64	....	4·09	....
Store pig	2·01	....	5·02	....
Half-fat ox	1·27	1·53	3·17	3·83
Half-fat old sheep	2·11	2·51	5·27	6·28
Fat and very fat animals:				
Fat calf	1·00	1·54	2·49	3·85
Fat ox	2·31	2·76	5·78	6·91
Fat lamb	3·39	4·40	8·49	11·01
Fat sheep	3.96	4·37	9·89	10·93
Very fat sheep	6·07	6·28	15·18	15·69
Fat pig	4·71	4·48	11·77	11·20
Means:				
Store and half-fat animals	1·76	2·02	4·39	5.05
Fat and very fat animals	3·57	3·97	8·93	9·93
Of the ten animals analyzed	2·85	3·48	7·11	8·71

For comparison with these ratios of the nutritive constituents of animal foods, wheat-flour bread was selected as one of the most important of the representative articles of vegetable food. The fat in the bread itself, estimated at one per cent, which is probably above the average, was reckoned in its equivalent of starch, and the ratio of nitrogenous and non-nitrogenous constituents was then found to be 1 to 6·8. Of the animals fattened for the butcher's use, the fat calf, only, gives a smaller proportion of non-nitrogenous constituents than the bread; the fat ox has nearly the same, and the other animals very much more. The averages also show that beef, mutton, and pork, on the whole, are not deficient in carbo-hydrates or non-nitrogenous nutritive constituents. After a full discussion of the subject, Drs. Lawes and Gilbert come to the conclusion that the great advantage of a mixed bread and meat diet, over one of bread alone, does not depend on the nitrogenous substance, but rather in substituting fat for a portion of the starch of vegetables. From the greater value of fat as a source of energy, and the general advantages of a variety of nutritive elements in the composition of a diet, this view of the influence of animal food seems to be well founded.

The limits of this article will not allow us to notice the experiments with sewage, and the feeding value of sewage-grown crops in the production of meat and milk; or the milling products of grain grown under a variety of conditions, and other special subjects of investigation, that have been included in the work at Rothamsted.

It is perhaps worthy of notice that nitrogen was the prominent object of interest in the Rothamsted field experiments, while the carbo-hydrates or non-nitrogenous constituents of the food seemed to

be the ruling elements in the feeding experiments. Is this apparent contrast in the materials required as leading factors in the economy of plants and animals a mere coincidence arising from the methods of investigation, or does it represent one of the correlations of organic life concerned in the conservation of energy? The mineral and nitrogenous constituents of plants are taken up by their roots from the soil, which is almost, if not quite, the exclusive source of these elements of plant-growth, while all of the carbon is elaborated by the leaves from the supplies in the atmosphere. The mineral and nitrogenous constituents of the food of animals, on the other hand, are all discharged from the system, after performing their functions, in the liquid and solid excretions, and thus find their way to the soil, where they can be appropriated as plant-food; while a large proportion of the carbo-hydrates are exhaled in respiration as carbonic acid, the atmospheric food of plants. By this constant circulation in their appropriate channels the conservation of the nutrient elements, of both plants and animals, is fully maintained.

The legitimate objects of agricultural experiments are too often overlooked, and it is certainly a satisfaction, in a review of experiments that have been systematically prosecuted for so many years, on such an extended scale, to find that they have been fully appreciated throughout the entire work. In one of the first reports of experiments at Rothamsted, on turnip-culture, published in 1847, it is said, "The object of the experiments has not been the production of immense crops, but to trace, as far as we were able, the real conditions of growth required by the turnip, and to distinguish these from those of the crops to which it is, to a great extent, subservient." In this endeavor to trace the laws which underlie the phenomena under investigation, results of permanent value have been secured; and the practical benefits, measured in pecuniary values, which have been derived from them are of greater importance from the fact that they are not merely empirical and detached facts that are true only under certain conditions, but have a foundation in principles of general application. Too often experiments are made in which the practical or pecuniary ends are the direct and immediate objects of inquiry, but such efforts, in the main, must result in disappointment, so far as any permanent interest is concerned, from the failure to trace the results obtained to their appropriate causes.

The work so well begun at Rothamsted is now carried on with undiminished energy, with a prospect of still more important results in the future. Dr. Lawes is now expending in his experiments more than $15,000 annually. A new building will be erected next year to relieve the laboratory from its accumulated stores of samples, that have a definite history and form the materials for future investigations. From five to nine hundred samples of the ash of experimental crops are collected each year, and with each sample of ash there is a dupli-

cate plant that is dried and bottled. With the true spirit of an original investigator, who sees that there is more to be learned than has already been discovered, and with a modesty that well becomes one who has accomplished so much, Dr. Lawes (now Sir John Bennet Lawes) writes me: "We are getting greatly in arrears of what may be called published work, and both Dr. Gilbert and myself are much more interested in searching after the unknown than in making public what little we do know. I think, however, it is not right to keep back so much valuable matter, and I shall try and publish next year the whole series of our ash analysis, without comment of any sort, merely giving the history of the experiments in regard to manures, etc., so that the reader may be able to trace the remarkable changes which take place from time to time. You will see that we have got to a point in our experiments in which the mere growth of the crop is one item, and a very small one, in the scope of our inquiry; the relations of the crop to the manure and to the soil and atmosphere bring us face to face with problems of great difficulty, which require several life-times to elucidate."

RECENT ADVANCES IN PHOTOGRAPHY.*

By Captain ABNEY, R. E., F. R. S.

TAKING the case of a daguerreotype plate which has been exposed, and which we are about to develop by the action of mercury, I should like you to understand exactly what takes place in the plate when it is exposed and developed. On the surface of the plate we have a mixture of silver iodide and bromide; but, for simplicity's sake, I will suppose that it is simply silver iodide. When light acts on such a compound, the result is the liberation of iodine and the formation of a new salt, which we call silver subiodide, $Ag_2I_2 = Ag_2I + I$. The iodine is taken up by the silver plate at the back of the sensitive film. To develop the picture, mercury-vapor is caused to condense on the subiodide, and leave the iodide intact. In the Talbotype process, the picture, which has been taken on a paper that has been washed with nitrate of silver, iodide of potassium, and nitrate of silver again, is developed by washing with gallic acid and silver nitrate. The picture begins to appear on washing after a very short exposure to the light, and becomes gradually more visible as the washing goes on. A paper process is a most fascinating process, because you can dabble about, and do exactly what you like; it is not like the gelatine plates of the present day, which you have to leave to come out mechanically. With paper, if you want to bring out a little better detail in one place,

* Abstract of four Cantor Lectures delivered before the Society of Arts.

you can dab it out, and, if you want to keep it back, you can put a little water over the place. There is no process like the paper process to please an artist. Now, what is the meaning of the development in this process? This morning I was in my laboratory, and I saw lying on the bench a feeble negative which I had badly developed, and which I had fixed with hyposulphite of soda. On taking it up, I found the salt had crystallized over the surface in the most beautiful manner; and I do not think I could point out to you anything which would give you a better idea of what development is than those crystals. When you have silver precipitated from a solution by any means whatever, you have it always in a crystalline form, and, as all crystals possess polarity, so crystals of silver possess polarity; and where one silver particle is deposited, there another silver particle will deposit. I look upon this as a physical development; we have a crystalline action going on during development, and nothing else. The iodide of silver is altered into a subiodide, and this, like the pole of a magnet, attracts the precipitating silver, and from that time, where the silver is deposited, other crystals of silver are deposited. That is what I call physical development.

There is another kind of development which some call chemical development; it is shown by a change in the color or material of the substance acted upon, and not by a building-up process, such as we have just had illustrated. The process may be illustrated in the development, by means of silver nitrate, of a picture which has been printed on nitrate of uranium. The picture is formed by silver oxide reduced by the particles of uranium nitrate which have been acted upon by light, and by nothing else. The silver oxide reduced is an exact equivalent of the uranium salt which has been acted upon by light. This differs from the previous process in that the gallic acid, in the one case, reduces the silver solution to the state of metallic silver; and, in the other case, the uranious image itself reduces it to the state of silver oxide.

Another mode of development, called chemical development in Germany, may, I think, more properly be termed alkaline development. Its theory is, that when you have a strongly oxidizing agent in the presence of an alkali and a silver compound, solid or in solution, the last will be reduced to the metallic state. Such an oxidizing agent we have in pyrogallic acid, and the alkali generally used is ammonia. Now, this kind of reduction is evidently useless, unless it can discriminate between a compound which has been acted upon by light and one which has not. When pyrogallic acid is used, in order to make the discrimination, something more has to be added as a restrainer to cause the reduction inducing the change to take place only in the part acted upon by the light. A solution of the bromide of an alkali is generally used for this purpose. Without a restrainer, the tendency is for those parts to be first reduced, but the action extends to that

which has not been acted upon by the light. It has been usually said that alkaline development is only available for bromide of silver, but my experience has taught me that iodide of silver is as amenable to alkaline development as the bromide, although not so rapidly, and that chloride is very amenable to it, and will give most beautiful pictures.

Another mode of development, now very much in vogue, is that with ferrous oxalate. In this case we have an organic salt of iron in the ferrous state, which is capable of reducing silver bromide, iodide, and chloride to the metallic state, while itself is reduced to the ferric state. This process also requires a restrainer.

I have found a kindred developer, the use of which I consider one of the most recent advances in photography. It is an iron developer, which is capable of being used without any restrainer whatever. I call it ferrous citro-oxalate. It is made by adding to a solution of citrate of potash ferrous oxalate till no more will dissolve; the resulting compound is probably citrate of iron, but in a stronger form than is usually found.

Mr. Berkeley has lately introduced an improvement in the ordinary alkaline developer, in which he mixes with the pyrogallic-acid solution four times the weight of sulphite of soda. The action, apparently, is that the sulphite of soda absorbs the oxygen with greater avidity than does the pyrogallic acid, thus leaving that agent to do its work; consequently, we have a developer which remains uncolored for a very long period.

Another developer, which is competent to work also without a restrainer, but has not been used to a very great extent on account of its high price, is hydro-kinone. It is a much more powerful absorber of oxygen than pyrogallic acid, to such a degree that one grain of it is as active as two grains of that substance. Not requiring any restrainer, even when so troublesome a salt as silver chloride is used, it is able to give a better detail and allow a shorter exposure in the camera than when the ordinary alkaline developer is used. It is applicable to any plate with which you can work.

The next point to which I wish to call attention is the action of sensitizers. It may be proper first to explain what a sensitizer is. When you have chloride of silver exposed to light, you have a new compound formed, which is called subchloride, or argentous chloride ($Ag_2Cl_2 = Ag_2Cl + Cl$), and chlorine is liberated. This chlorine is very difficult to eliminate, if you do not give it something that can take it up; for instance, if you place perfectly pure chloride of silver *in vacuo*, without any trace of organic matter present, you will find that you get no darkening action, even if it is exposed to brilliant sunlight for months. If a white powder of the kind was submitted to you, to determine its character, you would say at once that it was not chloride of silver, because it was not darkened, since one of the

tests of chloride of silver, among chemists, is that it shall darken in the light. Here I have a little bulb of it which was prepared, dried carefully, and sealed up. It has been exposed for months to the light, and is as pure a white as it was the first day it was put into the bulb. Another experiment was made at the same time; but, unfortunately, as I thought then, a small globule of mercury got into the vacuum, and was sealed up with the chloride; the consequence was that the chloride of silver immediately darkened: although the mercury was not in contact with the salt, the chlorine flew to the mercury, and formed chloride of mercury. This is an instructive experiment, showing that chloride of silver will darken merely in the presence of something that will mop up the chlorine. Silver iodide, when exposed to light, splits up into silver subiodide and iodine, and silver bromide into silver subbromide and bromine. Now, in order that there shall be a ready darkening of either of these salts, you must have something which will absorb the iodine or bromine (or, in the case of the latter, allow it to escape), according to the salt you expose to the light. This something is the sensitizer.

One point that has exercised the minds of a great many photographers is the illumination of their dark rooms. [The lecturer having shown the relation of the several parts of the solar spectrum with the absorption properties of different substances used in photography, proceeded to demonstrate the effect of differently colored glasses upon the passage of rays, and announced his conclusions.] If photographers want to have an absolutely safe light in developing their pictures, let them glaze their studios withe obalt glass and stained red, and they will get nothing but the light of that particular refrangibility, which will not affect any gelatine plate of the ordinary type. You may glaze and glaze with ruby, but you will never get rid of blue light entirely. Of course, it diminishes with every thickness you take. If you want to use ordinary plates, which are not so sensitive that you can not look at them, my advice is to use a combination of stained red and ruby glass, which will give you a comfortable light to work in, for it cuts off the blue and leaves the red in a brilliant patch. If the operator wishes to be still more secure, let him use a combination of cobalt glass and stained-red glass. A combination of red and green is a fairly safe light for iodide plates or ordinary plates, but not for gelatine plates, which are very sensitive. Next we come to a series of pretty colors, which may be very useful to us: magenta, with which the yellow is cut out entirely, and the green, leaving the blue, violet, and orange; aurine and chrysoidine, which cut off the blue; a combination of magenta and aurine, which gives a perfect red light, and is very good indeed for the photographic studio; and scarlet and aurine, which give the same effect. If all means of securing the right light fail, the photographer may use the ferrous oxalate developer, for you may bring the most sensitive plate out into a white

light, when developing in a dish with a covering of that substance over it.

In 1874 the discovery was made that an increased action of the spectrum could be got by dyeing the film of sensitive collodion. If you take one of the aniline dyes and expose it to the light behind a piece of black paper, you get an image on the dye. What is the meaning of that? The meaning is, that the dye is oxidized, for, if you apply an oxidizing agent, you get the same result. Dr. Vogel found that if he dyed a plate with one of these fugitive dyes, he was able to obtain an extension of the impressed spectrum, and he introduced the term "optical sensitizer" to describe the fact. I object to the term, for it gives a wrong impression of the action that takes place, which is simply the reduction of the iodide or bromide of silver by the oxidation of the dye, and the provision of a nucleus on which development can take place.

Collodion emulsions have been in vogue for seven or eight years, although they have now been superseded, to a large extent, by gelatine emulsions. Whether the last be an improvement over the former process or not, the collodion process is admirably adapted for landscape-work. If the emulsion is of silver bromide or chloride, it is easily formed; an iodide emulsion is more difficult. The point in emulsion-making seems to be to get the precipitate in as fine particles as possible, and it is said that this can only be obtained, except at very great cost of time and trouble, by first adding the soluble bromide or iodide to the collodion. If you take the trouble to add the silver to the collodion first of all, the aspect of emulsion-making is entirely changed, and you can get any amount of fineness by adding the iodide or bromide to the silver contained in the collodion so long as you keep the silver nitrate in excess. If you put the iodide into the collodion first, and then add silver nitrate, you will find that you have precipitated the iodide of silver at the bottom of the bottle, and in a form which will not emulsify at all. My advice to those who wish to make collodion or gelatine emulsion is, to add the silver to the collodion or gelatine, and then add the haloid salts afterward, and you will get as perfect an emulsion as you choose.

It is a great comfort in the collodio-bromide process that the operator is able to give local intensity (a most desirable quality in all artistic work) to the image. I do not believe any process is perfect until that power is placed in the hands of the manipulator; and the great defect of the next process to be mentioned is, that it does not give that power, but leaves the operator at the mercy of his plate, on which he must let come out what will. This next process is the gelatine process, which may be described as one in which the silver bromide is held in suspension in gelatine in the same way that in the previous process it is held in collodion. Mr. Bennett showed how a gelatine emulsion can be made very sensitive by keeping it at a comparatively

low temperature in a liquid condition for many days. Colonel Wortley afterward claimed that he could get the same sensitiveness by heating up to 150° Fahr. for a short time; and then Mr. Mansfield got it in a few minutes by boiling. Another method was then introduced by Dr. Monkhoven for the production of very sensitive gelatine emulsions by adding ammonia with the nitrate of silver. The ammonia process found many admirers, among them Dr. Eder, whose method of adding a large quantity of ammonia has given very sensitive pictures, and very vigorous ones when the sensitiveness is not too great. A process introduced by Mr. Cowan is even superior to that of Dr. Eder. He emulsifies his bromide in a very small quantity of gelatine with ammonia, and adds sufficient gelatine when the emulsion is ripened. Dr. Eder's method was to add the full amount of gelatine with the ammonia. Mr. Cowan's method gives greater rapidity and greater certainty.

What is the reason of the sensitiveness of the gelatine emulsion? Pictures can be taken with it in a tenth of the time necessary for a wet plate, and perhaps a thousandth of that necessary for an ordinary dry plate. The first reason is, that the emulsion has a blue form. Another reason is, that you can use a more powerful developer. If you separate bromide of silver which has been emulsified in gelatine, and place it in collodion, the extreme rapidity will be gone, for the simple reason that you can not use as strong a developer as you can with a gelatine emulsion; in fact, the property that gelatine possesses of acting as a physical restrainer comes into play: each little particle or aggregation of particles of the salt is surrounded by gelatine, which prevents the developer acting rapidly on them. Again, the fact that by boiling, or by the ammonia process, you get a coarser deposit of bromide of silver, also points to increased sensitiveness. Furthermore, if you boil or heat bromide, or any haloid salt of silver, with an organic substance, it has a tendency to separate into a metallic state; in fact, the bromide of silver is then in a state of very tottering equilibrium; the bromine is ready to be given off at the very slightest disturbance of the molecule, much more so than before it is boiled. I think that the fact that you so often get fogged emulsion when you overboil is proof of this statement. If you were to ask me to illustrate the sensitiveness of a gelatine plate, I should show you, not some of those marvelous instantaneous photographs, but a photograph by Mr. Henderson, by moonlight, and another of some under-ground cellars at Reigate, by Mr. William Brooks, taken by lamp-light. If anything can show what gelatine plates can do, it is the fact that candle-light and moonlight can be utilized for impressing the surface with an image. Dr. Vogel has recently introduced an emulsion made with acetic acid, gelatine, pyroxyline, and bromide of silver, which is very clean and very fairly rapid. Plates are more readily coated with it than with gelatine emulsion, but less so than with collodion emulsion.

Another very decided advance in photography is the doing away with glass as a support for the emulsion. Mr. Warnerke has perfected a process by which the photograph is taken on paper instead of on glass. He has a sensitive tissue which can be made of any length, and can be rolled on a roller and exposed in the dark slide. By turning another roller, a fresh surface is brought into the plane of the focusing-screen. The sensitive tissue is developed in the ordinary way with alkaline development. The film can be either stripped off, or else transferred to glass. In the latter case, we come to another point which marks a distinct advance. Mr. Warnerke has found that when you develop a gelatine plate with alkaline development, the parts which have been acted upon by light, and which have been developed, become insoluble in hot water. He is thus able, after development, instead of using the hyposulphite bath to fix the print, to transfer it to glass, and wash away with hot water the parts of the film which have not been acted upon by the light ; and he thus gets a transparency. To do this, it is necessary that the back surface of the gelatine film should be exposed to the water, as in carbon printing, and this is secured by transfer to glass. Mr. Warnerke is not satisfied with doing away with glass for the camera, but he does away with glass for printing ; and, in order to accomplish this, he retransfers the negative from the glass to a sheet of gelatine. I may say that the glass is freshly collodionized, and this enables the film to strip off readily. It is one of the advantages of these negatives that you can print from either side, each one yielding sharp points—a desideratum when using processes where reversed negatives are required. In the matter of gelatine films, we have Professor Stebbings's, which are really workable. The gelatine emulsion is apparently flowed on an insoluble film on glass, which is then stripped.

The next point I touch upon is the enlargement of negatives. The best way I know of, of getting an enlargement of a negative, is one that was brought forward a few years ago by Mr. Valentine Blanchard. He takes the original negative which he wishes to enlarge, and places it in an enlarging camera. He then takes a transparency of the exact size he wants his negative to be. He next takes a piece of common albumenized paper, and prints that transparency upon it, and by this means gets a very soft and beautiful negative. If you have a hard negative, it is almost impossible to get a soft transparency by the wet-plate process ; but, by this artifice of "printing out" your transparency and using that as a negative, you get a decidedly soft paper negative.

One of the new applications of the gelatine process is the development of a print on paper coated with gelatino-bromide. The paper is prepared by coating ordinary paper with gelatino-bromide (of the most sensitive kind, if you like). Such paper can then be exposed to the image formed by an ordinary magic-lantern ; by that means you

can get an enlarged print. We may thus say that an advance has been made, when, by an ordinary magic-lantern, with a good negative, you can get a perfect enlarged print by development. Perhaps it will not have that luster which albumenized prints have, but it is a matter of taste whether you like that gloss or not.

As gelatine plates are now prepared they all have an excess of soluble bromide. While this is the case, the highest sensitiveness possible will not have been obtained. Dr. Eder has found that an increase of sensitiveness, two or three fold, may be produced by neutralizing this excess. The gelatine-plate makers have the problem to solve, how to get rid of any possible excess of soluble bromide in their films.

We will next consider what causes the destruction of the photographic image. You may destroy it by any substance which will readily part with oxygen. You can destroy it, for instance, by bichromate of potash, by any of the ferric salts, or by oxygen-yielding substances, like permanganate of potash, ozone, peroxide of hydrogen, or hydroxyl; in fact, there is hardly any substance which will part with oxygen, which will not destroy the developable image. The photographic image remains behind as a rule, though not always, but these re-agents prevent it becoming developable. Bromine also acts sometimes as a destructive agent, by escaping, when the exposure is too long, from the lower part of the bromide coating of the plate, and forming a fresh film of bromide at the surface after it has been acted on by the light.

A remarkable utilization of the oxidizing process has been proposed and carried out by M. Bolas. Wishing to reproduce an ordinary gelatine negative having the proper gradations of light and shade, he took a gelatine plate, immersed it in bichromate of potash, allowed the film to dry, and then exposed it to light behind the negative to be reproduced. In this exposure he had an oxidizing agent present in his film; the oxidized parts were acted upon by the light, leaving the other part intact; and by that means he got a reversed image. Oxidizing agents enable us also to get rid of fog. A gelatine plate, which has been fogged by exposure to light, can be cleared by immersing it in bichromate of potash.

I have learned in my experiments that halations, or the appearance of haloes around the picture can be prevented, by touching the back of the plate with asphaltum or some varnish; the reflection is toned down according to what medium is placed on the back of the plate. The most perfect cure for halation is Brunswick-black. It admits no reflection from the back of the plate, and thus enables the operator to get rid of every tendency to fuzziness of the image.

A most useful instrument has been introduced by Mr. Warnerke, which is known as a *sensitometer*, or measurer of sensitiveness. it consists of squares of colored gelatine of different opacities through

which light is allowed to fall on a sensitive plate, and is intended as a guide to determine the comparative rapidity of the plates. Mr. Warnerke has also introduced an actinometer, or instrument to measure the intensity of light, which is dependent on phosphorescence for its value. It consists of a phosphorescent tablet, by the exposure of which to the action of light he is able to tell the photographic value of the particular light. The discovery is of the more value, because phosphorescence is induced by very nearly the same rays as those which affect bromide of silver. Another simple way of telling the amount of exposure to give the plates is by Woodbury's photometer, in which a piece of bromide paper exposed to the light is compared and read off with one of a series of tinted circles. A rule to be remembered in using this instrument is, that if a bromide plate is used, a bromide paper only should be used for securing the tint; if a chloride plate, a chloride paper. Recent researches of mine have shown that the darkening intensity and the developing intensity go hand in hand; therefore, when the operator has the number which gives the right tint, he may always be sure of getting the right exposure.

Some of the most recent and striking exemplifications of the scientific applications of photography are the composite photographs by Mr. Galton, which may be peculiarly useful in the study of anthropology. One of them is a typical family composite portrait composed of a mother and two daughters, in which all three faces are blended together. We are thus given a likeness of the female branch of the family; another, a blending of the father and mother, two sisters, and two brothers, gives the typical family group. Other pictures, in which the same principles are applied, give a typical group of engineer officers and a typical group of sappers.

SKETCH OF PROFESSOR HENRY DRAPER.

NO greater calamity could have befallen American science than the recent and sudden death of Professor Henry Draper. The news of it was an inexpressible shock to his friends, and was felt with painful regret by the whole community. But forty-five years of age, with the full promise of apparent health, and in the midst of an active and a brilliant career, he was cut off by an illness so short that but few had heard of it when his death was announced. In an excursion to the Rocky Mountains, in August and September, he had been subjected to severe exposure and contracted a heavy cold; he returned, however, in October, considerably recovered and able to resume his scientific labors. He gave a dinner to the National Academy of Sci-

ences, at his residence, on November 16th, and made special and elaborate preparations for the occasion by electric illumination of the dining-hall in a way to produce some novel and agreeable effects. It is supposed that the anxiety and exertion of this preparation were more than he could well endure. He was attacked with severe pains in the chest, and suffered much while at dinner, but thought that he would get relief by a warm bath. But, instead of relief, his symptoms were aggravated, and a physician was sent for who recognized his attack as one of violent double pneumonia and pleurisy. It was hoped, however, that he might recover until shortly before his death, which occurred early in the morning on the 20th of November.

HENRY DRAPER was born in Prince Edward County, Virginia, March 7, 1837, and two years later his father, Dr. John William Draper, removed to this city to take the chair of Chemistry in the New York University. Henry, at first, went through the course at the public school, but at the age of fifteen he entered the Academic Department of the university, though he did not graduate there. At the end of his sophomore year he entered the Medical Department of the university, which his father had been prominent in establishing, and from which he took his medical degree in 1858. He at first thought of practicing medicine, and received an appointment upon the medical staff of Bellevue Hospital, which he held for sixteen months, and then decided to abandon practice, and give himself to teaching. He was elected Professor of Physiology in the Academical Department of the university in 1860, and in 1866 became professor of the same branch in the University Medical School. He resigned this post in 1873, and afterward taught advanced analytical chemistry in the Academical Department of the institution. After the death of his father he was appointed to fill his chair, but previous to the opening of the last fall term he severed entirely his connection with the institution.

Professor Henry Draper is one of the men who is not to be interpreted in his individuality alone. With his father he represents one of the double stars in the firmament of scientific celebrities of which we have now a considerable catalogue. Among the illustrious pioneers of mathematical physics there are the Bernoullis, father and son; in chemistry, the Gmelins and the Brodies; in botany, the De Candolles and the Hookers; and, in astronomy, the Cassinis and the Herschels; and to these must be added the Drapers, father and son. Many more examples, though less eminent, might be given in which sons have distinguished themselves by pursuing with success the branches of research opened by their fathers, and to trace the influence that is exerted and the effects that are produced in these cases would be an interesting biographical study. In the present instance the son was the inheritor both of his father's genius and of his subjects of research, while his early education was shaped with a view to the pursuits to which his life was devoted. This point is thus referred to in the

sketch of Henry Draper which appeared in a late number of "Harper's Weekly":

"He had for a companion, friend, and teacher, from childhood, one of the most thoroughly cultivated and original scientific men of the present age, who attended carefully to his instruction, and impressed upon him deeply the bent of his own mind in the direction of science. The boy was, in fact, immersed in science from his youngest years, and not merely crammed with its results, but saturated with its true spirit at the most impressible period. He was taught to love science for the interest of its inquiries, and was early put upon the line of original investigation in which he has won his celebrity. Henry Draper inherited not only his father's genius, but his problems of research. Dr. John W. Draper was an experimental investigator of such fertility of resources and such consummate skill that the European *savants* always deplored his proclivity to literary labors as a great loss to the scientific world. Henry Draper inherited from his father in an eminent degree the aptitude for delicate experimenting, and a fine capacity of manipulatory tact. The elder Draper was one of the founders of the recent science of photo-chemistry. He worked early and brilliantly in the new and fascinating field of the chemistry of light, and more than forty years ago by his extensive contributions to this subject he prepared the way for those who entered to reap the fruits of his labors in the splendid field of spectrum analysis. But the scepter was not to depart from the family. Henry pursued the same line of research, and by his extension of it will have a permanent place among the discoverers of the period."

Henry Draper's first important scientific investigation was made at the age of twenty, and was embodied in his graduating thesis at the Medical College. It was on the functions of the spleen, which was illustrated by microscopic photography—an art then in its infancy. Soon after receiving his degree he went to Europe, and while there visited the widely-known observatory of Lord Rosse, and studied the construction and working of his celebrated colossal reflecting telescope. This led him to consider the problem of using reflecting telescopes for the purpose of photographing celestial objects. On his return home he constructed a telescope of this kind of fifteen and a half inches aperture, and with it took a photograph of the moon fifty inches in diameter—the largest ever made. His success spurred him on to further improvements, so that he became an adept in grinding, polishing, and testing reflecting mirrors. An equatorial telescope was afterward constructed by him, with an aperture of twenty-eight inches, for his observatory at Hastings-on-the-Hudson. The instrument was wholly the work of his own hands, and was designed mainly to photograph the spectra of the stars. After a long series of experiments, it was finished in 1872, and has been pronounced by President Barnard as 'probably the most difficult and costly experiment in celes-

tial chemistry ever made.' He was the first to obtain a photograph of the fixed lines in the spectra of stars, and he continued the work until he had obtained impressions of the spectra of more than one hundred stars.

When the commission was created by Congress for the purpose of observing the transit of Venus, in 1874, Professor Draper was intrusted with the charge of the photographic department. He spent much time in the preparations, for which he declined to receive any compensation. So signal was the success of his disinterested exertions, that the commissioners had a gold medal struck in his honor at the Philadelphia Mint, bearing the inscription, though in an extinct tongue, "He adds luster to ancestral glory." In 1878 he went to the Rocky Mountains to observe the total eclipse of the sun, and there successfully photographed the spectrum of the solar corona. For the last two or three years he had been much engaged in the difficult work of photographing nebulæ, and he startled the scientific world by the announcement that he had succeeded in getting a fine photograph of the great nebula in Orion and of its spectrum.

Professor Draper was not a prolific author, like his father, and only wrote one book; but he died in the prime of life, and had he lived would undoubtedly have given to the world the results of his ripened investigations in enduring treatises. He, however, wrote much for the scientific periodicals, describing the results of his work. He contributed several papers to the "American Journal of Science and Arts" and to "Nature." He published in 1864 a "Text-Book of Chemistry," and a paper on the "Philosophic Use of Silvered Glass Reflecting Telescopes." The paper was published in "The Philosophical Magazine." In the same year he published a pamphlet on "Silvered Glass Telescopes and Celestial Photography." "The Quarterly Journal of Science," in 1865, published his views of "Petroleum, its Importance and its History," and "American Contributions to the Spectrum Analysis." The Smithsonian Institution, in its "Contributions, vol. xiv., of 1864," published a paper on "Construction of Silvered Glass Telescopes, Fifteen and a Half-Inch Aperture, and their Use in Celestial Photography." The following papers have been published in "The American Journal of Science and Arts": "On the Diffraction Spectrum Photography," in 1872; "Astronomical Observations on the Atmosphere of the Rocky Mountains," and "Spectra of Venus and α Lyræ," in 1877; "Discovery of Oxygen in the Sun by Photography, and a New Theory of the Solar Spectrum," which was followed by another paper on the same subject, entitled "On the Coincidence of the Bright Lines of the Oxygen Spectrum with Bright Lines in the Solar Spectrum," in 1877; "Eclipse of the Sun in July, 1878," in 1878; "Photographing the Spectra of the Stars and Planets," in 1879; "Photograph of Jupiter's Spectrum," and "Photograph of the Nebula in Orion, on September 30, 1880," in

1880; and "Photograph of the Spectra of the Comet of June, 1881," last year.

Probably Henry Draper's most important work was his discovery of oxygen in the sun, which was duly chronicled and made a matter of discussion in "The Popular Science Monthly" at the time. It was the result of great sagacity, experimental skill, and an immense amount of labor. It was too unexpected and surprising to command the ready assent of eminent physicists and astronomers, while its experimental proofs were on such an expensive scale that the processes could not be easily repeated. But the opinion has undoubtedly gained strength that the discovery is valid, and by reference to a recent work by Professor Young on "The Sun" and the "Popular Astronomy" of Professor Newcomb, it will be seen that the weight of authoritative opinion is in favor of its reality.

Henry Draper was a man of medium height, rather stoutly built, with the appearance of vigorous health. His manners were agreeable, he was a lively and a witty talker, and a very fluent and instructive lecturer. He was enthusiastic in his passion for science, and persistent and tenacious in carrying out his elaborate plans of research.

In 1867 he married the daughter of Courtlandt Palmer, Esq., a cultivated lady who entered with a kindred enthusiasm into all his studies, and rendered the most faithful and efficient service in his delicate and arduous investigations. So thorough was her understanding of the problems he was engaged upon, and so considerable her share in the manipulatory practice, that it is hoped she may be able to complete and publish his more important unfinished work. At the death of his father-in-law, Professor Draper became a trustee of the large estate, and was henceforth much absorbed in business. But, though in command of very liberal means, his passion for science was too strong to be diverted by new solicitations, and he set a noble example by making use of his ample resources to carry on the work of scientific research on a scale that is but rarely attempted because of its great expense.

EDITOR'S TABLE.

THE BANQUET TO HERBERT SPENCER.

ALTHOUGH the visit of Mr. Spencer to this country has been in some respects painfully unsatisfactory, yet in other and the most important respects it has been most gratifying and successful. His state of health was such that he was good for nothing for social purposes. He has been long an invalid, and compelled much to restrict his social life at home. He left England in a bad condition, which was aggravated by his voyage, and then made worse by the exciting experiences of a new country, where he found many things very different from those he had been used to. Social intercourse was so exciting and exhausting that he was compelled to abstain from it, and many of his friends were sadly disappointed that they could not meet, welcome, and converse with him, as is the habit with other eminent strangers. This was a serious drawback upon his visit, equally to himself and to others, and will be a source of lasting regret.

But now that Mr. Spencer is gone, and has got home safely, everybody is glad he came. They are pleased that he has seen something of the country, if but little, and that he will have more correct and adequate ideas of what is going on here than if he had never come. It will be a fact of no small import, perhaps, in his mental history. But the chief significance and the most gratifying feature of his visit will be the way he has been received by the American public. If he has not been seen, he has been heard; and the wide effect is that he is both better known and more highly regarded by friends and enemies alike.

It had been determined by those interested in Mr. Spencer that some expression of public feeling should be made before he left, but it was long uncertain whether the state of his health would allow him to accept it. And, when at length he decided to do so, he at the same time found it necessary to shorten the time of his stay. This gave but a very limited opportunity to make the preparations for a banquet that should be at all adequate to express the interest of the occasion. Excellent dinners are, of course, very easy things to get up, and there are always plenty of fluent and sparkling speakers to add to them the pleasure of oratory. But there was something of seriousness in this affair that was not to be overlooked. We had with us, perhaps, the most eminent thinker in the world, and one whose name has now become identified with the greatest movement of thought in this age. It was every way desirable, therefore, that the demonstration should be made sincerely and even gravely expressive of American appreciation of Mr. Spencer's character, position, and work; and this was felt to be the more necessary as a bare act of justice, because his quiet and unobtrusive life has called forth no signal opportunities for the declaration of the profound regard entertained for him by many men of the highest intelligence. Representing no party or sect, supported by none of those associations that are so efficacious for the encouragement of talent, representing rather all that is most objectionable and unpopular in modern opinion, he has been left to the quietude of his solitary studies, and, while stamping himself deeply upon the mind of the period, he has been at the same time regarded as the most impersonal of men. This has undoubtedly had its advantages, and is not to be complained of. But it was very properly thought that, when he came to this country, where he is admired and venerated by multitudes who

are indebted to him for light, awakening, and emancipation, there should be some formal and decisive utterance of what may be fairly taken as the American estimate of the man. In obedience to this sentiment, the best arrangements were made that the time would allow for speeches more thoughtful and even solid than are usual on such complimentary occasions. The wisdom of the policy was abundantly vindicated. The temper of the gathering required that the addresses should not only be interesting, but weighty with appreciation of the opportunity. The guest of the evening was received with enthusiasm, and listened to in utter silence, that not a word should be lost. All the other speakers were received with the most cordial applause; and when Mr. Beecher ended his stirring and whole-hearted address, at twelve o'clock, there was a fervid enthusiasm on the part of all that broke into a common expression of pleasure at the success of the affair. Many others there were ready, and would have been glad, had time allowed, to join in the emphatic tribute of respect and admiration for the distinguished guest.

It may be added that the only drawback upon the Spencer banquet was the large number of those who were disappointed in not being present. Had there been more time for preparation, the committee of arrangements would have chosen a place capable of seating five hundred, instead of two hundred, at table; though, had publicity been given to the affair through the press, the same difficulty would have occurred on a larger scale.

THE QUESTION OF OVERWORK.

In his address at the complimentary dinner tendered to him in New York, Mr. Spencer took up the subject of overwork—criticised the Americans as faulty in this respect, pointed out the evil consequences of excess in this direction, said that it implied an imperfect social ideal, and intimated that as a people we need more relaxation. His criticisms and advice have been generally received as sound and proper, but they have also elicited protests in various shapes, some of which it may be well to notice.

Mr. Spencer's countryman, George Jacob Holyoake, was recently honored with a reception in this city, and in his remarks he referred to Mr. Spencer's criticism dissentingly. He is reported as expressing great admiration of American activity and enterprise. As for the people being in too great a hurry, he thought Mr. Spencer himself would get to be in a hurry if he staid here six months, in the midst of opportunities and competitions that are enough to make an angel hurry. Shrewd Englishmen understand that Americans love to be told that they are smart and beat the world in enterprise.

But can so clear-headed a man as Mr. Holyoake fail to see that there is a special danger where the tendency to exertion becomes so irresistible—where individual impulses are only intensified by surrounding influences? The greater the temptation the greater is the peril of success, and the greater the need of restraint. Will it be said that there is no such thing possible as injurious overwork, or that the powerful strain upon men can be safely kept up without corresponding counteractions? The very question is absurd. The common experience of human nature testifies that men can very easily kill themselves by over-exertion. The problem is simply one of a proper balance between opposing tendencies. Where there is great stress in the direction of laborious activity, adequate counter-checks are demanded. Mr. Spencer did not so much condemn strenuous work, in which, indeed, he believes, as the lack of compensating recreations to countervail its mischievous effects.

Mr. Seymour Haden, another of Mr. Spencer's countrymen, in a compliment-

ary reception speech, expressed also his quite emphatic disagreement with Spencer, and his admiration of the spirit of American enterprise and the splendid activity of the American people. As to the injury done by overwork, he did not believe in it, and the eminent physician, Sir William Gull, told him he had never known a man who had died from it. It is worry, not work, which kills, said Mr. Haden.

Undoubtedly, but is not the deadly worry one of the inevitable accompaniments and consequences of the overwork under the conditions of competitive enterprise in this country? It is work carried to such extremes as to engender anxiety and harassment under the fierceness of business struggles and the eagerness of unchecked ambition that is condemned. It is not claimed that the man who kills himself at fifty by unremitting labor has done it by too much physical exertion. He has done it by assiduous mental solicitudes without break or reaction, and the neglect of the conditions of health which that absorption of thought and strain of the feelings imply. Spencer's criticisms were leveled at the want of regulation and of a corrective in the shape of systematic relaxations that shall give more contrast in life, and greater freedom to the play of agreeable feeling, in place of the vexatious solicitudes which spring from devotion to work. To say that it is not overwork that kills, but the worry that is entailed, is merely to quibble with the subject. Sir William Gull might as well have declared that he had never known a case of death from cholera or consumption because it is the lack of power in the constitution to resist these diseases that is really the cause of death. It is only by such caviling that the notorious fact can be evaded, that thousands of men in this country sacrifice health and life to the passionate eagerness of business pursuits. Every observing person can give examples within the sphere of his own acquaintance of such premature breakdowns by the score.

The New York "Sun" gives an editorial to the subject, and maintains that the warning of Mr. Spencer is quite mistaken, as the Americans are far from being an overworked people. "There may be more fret and worry about money-making due to the haste to get rich, and the greater dissatisfaction with a position in mediocrity, but real overwork is not among our vices." But it would have been well to point out how "fret and worry about money-making," "haste to get rich," and "dissatisfaction with a position in mediocrity," operate to produce discretion in the regulation of our activities!

But the "Sun" gives expression to a criticism of Mr. Spencer which has been heard in various quarters, and requires attention. It intimates that he is under an objective illusion, and has simply generalized from his own morbidities to the condition of everybody else whom he saw. The editor says: "It is not at all remarkable that Mr. Herbert Spencer took this view of us, and that he made it the subject of the only speech he delivered while in the United States. Himself suffering from the lack of rest, he was naturally disposed to discover symptoms of the same trouble among the men in the strange country to which he had come on an unavailing search for repose. He had found in his American travels many nervous sufferers who could sympathize with him, just as every victim of a chronic malady, no matter how seemingly peculiar to himself, is sure to meet others who are more or less in the same state. His disease is naturally foremost in his thoughts, and his conversations are likely to lead up to it, so that he gets in the way of hearing of similar cases. There is a strong sympathy which brings together invalids of like kinds. They like to compare symptoms."

This is a very easy theory of the

case, but wholly groundless. Mr. Spencer is the last man to perpetrate a fallacy of this kind. He may be an invalid, but he is clear-headed enough to deal with this subject on its logical merits. When Mr. Schurz, at the dinner, made a reference to "dyspeptic philosophers"—although Spencer is a man of excellent digestion—Mr. Beecher aptly replied that, "at any rate, Spencer's books have no dyspepsia." It seems to have curiously occurred to many that the tables could be turned upon Mr. Spencer by referring to his own case, although for the life of us we can not see how his own experience of the very matter he was treating could have disqualified him from speaking upon it with pertinence and intelligence. But he did not choose to make it a personal matter, although if he had done so it would have redoubled the force of his argument. Mr. Spencer did undoubtedly break down badly, and long ago, and has suffered the painful consequences of it ever since.

But his invalidism has certainly been of a kind not to affect the clearness, rectitude, and soundness of his thought. His work for a quarter of a century is not only marvelous in its amount, but it is unparalleled in its originality, acuteness of insight, literary finish, and logical stability. No faintest taint can be traced anywhere in his books of the nervous exhaustion of their author. And the abundant reason is, that Spencer has followed his own prescription, and made relaxation, amusement, and recreation, in every form, a daily religious duty. By making work always subordinate to the unbending that is essential to its highest quality, he has proved the value of recreations as tributary, not only to length of life, but to the perfection of work. When, therefore, he spoke to the Americans upon the subject, and warned them of the dangers of their high-pressure civilization, we have no right to assume that there is any personal equation of unhealthiness on his part to be corrected. We are bound to take his advice as a sound thinker of unclouded discernment, and well disciplined in the work of drawing safe conclusions from discriminated facts.

But Mr. Spencer's argument is far from depending upon breakdown statistics that he may have observed or collected from others. The lesson that he inculcated is broadly derived from his social studies, and from his doctrine of the evolution of society. He pointed out that the social ideals of men are subject to change—that fighting as a universal passion has passed away, and that work as a universal passion has taken its place. In this there has been an enormous improvement, but the existing ideal is not a finality. It remains to take a further step forward by organizing more completely the means of human enjoyment. No advent of a poetical or prophesied millennium is to be expected, but men can nevertheless advance in this life to a happier state. And this becomes an immediate and practical question with every individual. The problem is only to be solved by making rational enjoyment, in larger measure, the object of life, and of each day in life. This is the proper end of knowledge and of work. It is true beyond question that the lives of immense multitudes in this country are narrowed down to the one absorbing gratification of money-getting, to the exclusion of all other gratifications. Of the nobler capacities of enjoyment they know nothing, and they have lost the power of even becoming interested in anything but the purpose that enslaves them. Can this be defended as a normal or satisfactory condition of the individual, or of a society largely composed of such individuals? Work is not an end, nor is study an end: work brings a surplus of means, and study should show how to use it for the most varied gratification—both should be tributary to completer and richer life.

No timelier or weightier message was ever delivered to a people than the farewell words of Herbert Spencer to the Americans on the eve of his departure from our shores.

THE BARTHOLDI STATUE.

EVERYBODY has heard of the enormous statue of "Liberty Enlightening the World," now nearly completed by Bartholdi, the French sculptor, to be presented to the Americans for erection in the harbor of New York. It is of magnificent proportions, the figure being one hundred and forty-five feet in height, and is intended to stand upon a massive pedestal of equal height. The arm of the figure supports an uplifted torch which will be a brilliant electric light at an elevation of more than three hundred feet above tide-water. It will be a splendid object of art, and certainly embodies a grand idea, standing as it will at the port of the commercial metropolis of the United States—an impressive symbol of the progress of political liberty.

The statue has been constructed at the cost of a quarter of a million of dollars, which has been raised by the subscriptions of a hundred thousand Frenchmen. It is to be presented by the great Republic of Europe to the great Republic of America, and its acceptance involves only the single condition that the American shall furnish a suitable foundation to support it. It will be ready for delivery and erection the coming summer, and it is therefore desirable to bestir ourselves to prepare for it. The pedestal is to be paid for, and will cost at least two hundred thousand dollars. There are a hundred American millionaires who would be delighted with the opportunity of defraying the whole expense if they could have the name of the donor engraved upon it in colossal letters, and thus make it a monument of selfishness, but it would be better to sink it in mid-ocean than to suffer its perversion in this way. It belongs to the American people to construct this pedestal, and it should be a burden upon nobody. Let half a dozen public-spirited and responsible men and women of each town organize themselves into a committee to obtain subscriptions from one dollar to twenty-five dollars, and the amount will soon be raised. It is no charity, and there needs to be no begging. There are plenty of people who would like to have a little stock in this new wonder of the world which will attract multitudes from the four quarters of the earth to behold it.

LITERARY NOTICES.

JAMES MILL. A Biography. By ALEXANDER BAIN, LL. D. New York: Henry Holt & Co. Pp. 426. Price, $2.

THE influence of John Stuart Mill upon the reputation of his father, James Mill, has been twofold: he has advertised him, and at the same time eclipsed him. It is frequently said of James Mill that his greatest work was John Mill; and there are many who suppose that this is his chief title to be remembered. Others think that, though the father may have been a man of some consideration in his time, yet that he has been so superseded by his son that all interest in him has disappeared.

But James Mill is not to be disposed of in this way. It is hardly questionable if James Mill is not, in fact, the greater and more original man of the two. If one is to be regarded as an appendage to the other, the order of time will correspond to the order of rank. No doubt the two Mills will have to be taken together as representative of one system of ideas. But the system, as such, belongs to the father much more than to the son. James Mill led in its development and John Mill followed. The son continued the father's work, expanding, extending, and elaborating it; but he inherited it as a half-constructed system, and, if the father was unable directly to give it its more developed form, he did it indirectly by educating his son entirely with reference to the

fulfillment of his own mission as the founder of a new school of philosophy.

In seeking to rectify past judgments and to form a more just idea of the relative greatness of these two eminent men, we must remember, not only that the father was self-made, while John Stuart Mill had James Mill for a teacher, but we must remember also that the father had to make himself over again after he had at first been very badly constructed. He was educated as a clergyman in the orthodox school of Scotch Calvinism, and was of course early saturated with the whole order of ideas which belongs to that system. From this he got himself free by a total rejection of the whole body of theological belief that belongs to Christianity. He therefore began the reconstruction of his views and opinions late in life, and had to work them all out for himself. His son, on the contrary, had the immense advantage of beginning early a systematic training in the line which he pursued without a break through life. James Mill was an independent and indeed a masterly thinker in the fields of psychology, of political economy, of logic and the philosophy of government, and he was a pioneer of modern English liberalism. John Stuart Mill ran in upon all these subjects, revising, amplifying, and making them his own through the accomplishments of a wider erudition and a more thorough preparation; but if he had possessed more of his father's quality he would have broken loose from more of his father's errors, and the system of thought that is now identified with both names might have been made more enduring than it is.

Dr. Bain's life of James Mill is a very interesting book. It is interesting in its biographical features and as a delineation of a strong and remarkable character; and it is also especially instructive as a history of the times, as illustrated by the active and influential career of a man who had much to do with the reshaping of modern liberal opinion in social and political affairs. James Mill was a man of immense intellectual activity, as shown not only by the "Analysis of the Human Mind" and the "History of India," but by a host of lesser productions, such as articles contributed to cyclopædias and to many of the leading reviews, all of which were able in thought and written with remarkable clearness and force.

THE WINNERS IN LIFE'S RACE; OR, THE GREAT BACKBONED FAMILY. By ARABELLA B. BUCKLEY. New York: D. Appleton & Co. Pp. 367. Price, $1.50.

As a popular scientific writer the position of Miss Buckley is now assured. Her knowledge is sound, her judgment trustworthy, and her power of elementary exposition much above the common standard. Her first book, "A Short History of Natural Science," was needed and was well done. The "Fairy Land of Science" was also excellent. "Life and her Children" struck into the new biological path, and gave an interesting account of the *invertebrates*, or the lower forms of living creatures. The present work is a continuation of it into a higher field, although the present is an independent and self-explanatory work.

The work we now have from Miss Buckley was much demanded. We wanted a popular book on the *vertebrates*, the backboned family from the historic or evolution point of view. This made necessary unusual qualifications in the writer, and implied a knowledge of geology and paleontology, as well as natural history. Miss Buckley had been for many years the secretary and special student of Sir Charles Lyell, and had therefore the best opportunities to become familiar with those branches that have now become indispensable parts of biology. Miss Buckley says of the method of her book:

"I have therefore endeavored to describe graphically the early history of the backboned animals, so far as it is yet known to us, keep strictly to such broad facts as ought in these days to be familiar to every child and ordinarily well-educated person, if they are to have any true conception of natural history. At the same time I have dwelt, as fully as space would allow, upon the lives of such modern animals as best illustrate the present divisions of the vertebrates upon the earth; my object being rather to follow the tide of life, and sketch in broad outline how structure and habit have gone hand-in-hand in filling every available space with living beings, than to

multiply descriptions of the various species. If my younger readers will try and become familiar with the types selected, either alive in zoölogical gardens or preserved in good museums, they will, I hope, acquire a very fair idea of the main branches of the Backboned Family."

This acceptance of the evolution standpoint, this tracing of the stream of life along the great course of terrestrial changes, this marking of the epochs of advancing organization in the ascending movement, and this tracing of genetic relationships, all concur in giving a new and impressive significance to the idea of unity in the great scheme of life, and give to natural history a new element of almost romantic interest. Miss Buckley has given attractiveness to the subject by her wealth of information, the clearness and simplicity of her descriptions, and she has heightened the effect by the skillfully conceived and finely executed illustrations with which the volume is filled.

HERBERT SPENCER ON THE AMERICANS, AND THE AMERICANS ON HERBERT SPENCER. Being a Full Report of Mr. Spencer's Interview, and of the Proceedings at the Farewell Banquet. New York: D. Appleton & Co. Pp. 96. Price, ten cents, or $5 per hundred.

THIS pamphlet contains the most for the money of anything that can be found in the market. It has been carefully prepared, so as to be entirely correct and authentic. The newspaper reports were defective and incomplete. The revised addresses of Hon. William M. Evarts, Mr. Spencer, Professor W. G. Sumner, Mr. Carl Schurz, Professor O. C. Marsh, Mr. John Fiske, and Rev. Henry Ward Beecher are given in full; and to these are added the unspoken speeches of Mr. E. L. Youmans, Mr. Lester F. Ward, and Mr. E. R. Leland, together with all the letters sent to the committee, and which have not before been published. The document is weighty with important thought that can not fail to dispel much prejudice, and every one who cares for the dissemination of truth should send on his five dollars and get a hundred to distribute among his neighbors. They will be sure to appreciate the favor.

UNITY PULPIT. SERMONS OF M. J. SAVAGE. Vol. IV. No. 9. Herbert Spencer: his Influence on Religion and Morality. Published weekly. Boston: George H. Ellis. Price, $1.50 a year, or six cents single copy.

THERE is no more encouraging sign of the times than the indications we see that the pulpit is beginning to yield to the spirit of progress. As science slowly advances in the reformation of knowledge, bringing new subjects under the influence of its method, regenerating the ideals of mankind, and making truth the supreme object of quest and devotion, it is, of course, impossible for the pulpit to remain unaffected by the general movement. The highest victory of evolution will be to transform the biased preacher into the unbiased teacher. The pulpit, as we have inherited it, is becoming more and more anomalous in these times. It is the place that has been sacredly protected from the competitions of inquiry. Everywhere else error goes merely for what it is worth, and must take its chances in the open conflicts of discussion, but in the pulpit error is consecrated. It is the bulwark of tradition. Beliefs that are outgrown and abandoned everywhere else find refuge in the pulpit. The preacher is the expositor of ancient creeds, the leader of a sect, a rhetorical homilist, anything except an independent seeker after truth. The virtue of the pulpit is submissive faith, its crime free-thinking. This characterization, of course, applies more to the past than to the present, but it is still too extensively true. There is, however, a silent, insidious, but inevitable change going on in a great number of pulpits that is loosening ancient prejudices, undermining past bigotries, softening theological asperities, and tending to a larger liberality in all religious matters. The position of the clergyman in a time of transition like the present is difficult, and, if he be a deeply conscientious as well as a clear-sighted man, is often painful. But many of them are learning how to meet the emergency, to yield gracefully that which must go, and to accept cordially that which must unavoidably come. Some pulpits, indeed, and their number is increasing, are already free. Their occupants are content to be simply teachers, and have liberated themselves from all trammels that tend to

hinder the promulgation of truth. The doctrine of evolution will certainly sweep away a large amount of old belief that has hitherto been venerated by its religious associations, but in various qualified forms the essential truth of that doctrine is already acknowledged in many pulpits where it is sure, as time goes on, to yield its liberalizing fruits.

Unity pulpit, in Boston, occupied by the Rev. Minot J. Savage, has long been emancipated from those restraints of dogma which hinder the acceptance of the great truths established by science. Mr. Savage has met the new questions of the time without hesitation and with a cordial welcome, holding that neither will a sound morality be weakened nor pure religion suffer through the extensions of science and the enlargement of the domain of truth. He maintains rather that a more authoritative ethics and more ennobling religious conceptions must be the inevitable result of that progress of thought which now finds its highest expression in the evolution philosophy. Unity pulpit at any rate is free, and its occupant is unable to perceive why in his sphere of inquiry he should not have exactly the same liberty of investigation that is exercised by every member of the National Academy of Sciences. His last sermon, now before us, is devoted to Herbert Spencer, and to an estimate of his influence on religion and morality. It certainly can not be said that the pulpit has hitherto sinned in the way of neglecting this representative thinker; but the utterance of Mr. Savage differs so widely from what we have been accustomed to hear from the lips of clergymen, that we have pleasure in quoting its opening passages:

> A quiet, modest, unassuming gentleman, with no assumption of greatness, with no air of pretense, with not the slightest approach to an appearance of patronage toward those who may be considered as less noted or great than himself, has been for the last two or three months seeking rest and refreshment here in America. Heard in public but once, seen in private only by a few, the country has still felt that a great man was here, a man like those to whom Emerson refers when he says, "A great man is himself an occasion." We have all felt this presence, and noted some indication of it now and then. For, when he has chosen to utter himself concerning the impressions that have been made upon him in this country, the whole nation has listened as though something were being said that was worthy of attention. The newspapers have caught it up; and all the leading organs for the expression of public opinion have commented on it, recognizing the fact that here at least was something not to be passed by in silence.
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> This man, to whom we have been so ready to listen, has during the last quarter of a century wrought a work that, I think I may say, without exaggeration, has no parallel in the history of human thought. He has so wrought himself into the very fiber, the warp and woof of this modern world, that I can say of him, what can be said of no other man living, and what has never been said of any man who has ever lived: he has made himself so vital a part of science, of philosophy, of education, of the science of government, of sociology, of ethics, of religion —he has so mastered and entered into the possession of all these great realms of human thought and human life, which in their totality almost make up what is meant by life itself, that to-day no serious and intelligent thinker can discuss any important question pertaining to any one of these departments without being compelled to reckon with Herbert Spencer. You can not discuss science, you can not discuss philosophy, you can not discuss education, politics, society, and the laws that underlie them, you can not discuss ethics, you can not touch the subject of religion, without either agreeing with or differing from this quiet scholar. And to have wrought himself so intimately and so essentially into the very life of the world—this, I say, is an achievement unparalleled in the history of human thought. I care not in which department you pick up a book to-day, you will find that the writer, if he comprehends his theme, is either working along the lines which Herbert Spencer has laid out, or else he is telling the world why he does not do so. He does not ignore him—he can not ignore him. About a week ago, it was my privilege and pleasure to join one or two hundred gentlemen in giving Mr. Spencer a public dinner in New York, on the eve of his departure. It was something striking and wonderful to see there the leading men of the nation in all departments of thought and culture, sitting at his feet and acknowledging his supremacy.

A PRACTICAL TREATISE ON HERNIA. By JOSEPH H. WARREN, M. D. Second and revised edition. With Illustrations. Boston: James R. Osgood & Co. Pp. 428. Price, $5.

THE author of this book is widely known as a successful practitioner and writer on hernia and kindred affections, and his aim has been to make this a trustworthy work of reference on the subject. The first edition was received in the most favorable manner by the profession; the present new edition has been improved with all the advantages that further studies and

continued experience in practice could enable the author to add. A new introduction has been written, and six new and carefully prepared chapters have been added, while a part of the old work, considered less essential, has been omitted. The volume contains a condensation of whatever seems most worth preserving from the world's literature on the subject, and much that is original with the author, embodying the results of his own studies for many years, and having never before been given to the public in a printed form. The treatise begins with a discussion of the causation of hernia, in fetal and infantile life and in adults, to which are added some remarks on its effects. Next are considered its kinds and frequency; its anatomy, descriptive and surgical, and strangulation. The essential purpose of the work is developed in the fifth chapter, in which the operations for hernia are considered generally; and the sixth, in which the author's own method is described and explained. Under the former head full justice is done to previous operators, all of whose methods that seem to have merit are candidly and impartially described and estimated; and acknowledgment is given for what the author has derived from them, particularly from Heaton's method, of which Dr. Warren's is a modification and improvement. The principle of Warren's method is the injection of an astringent solution to induce closure of the rings and canals, to produce what is commonly called a radical cure. This principle was suggested by Dr. Pancoast, of Philadelphia, extended and applied with much success by Dr. Heaton, and was brought to a higher degree of perfection by a more complete adaptation of the injecting instrument to the conditions required by the delicate tissues operated upon, and some modifications in the injected fluid, by Dr. Warren. All of the operations, from that of Chauliac to that of Wood, are declared to be "severe, and likely to be attended with great danger to life, if not absolute loss of it." No such arguments, Dr. Warren adds, "can be used against the operation that I recommend, as no fatal results have ever occurred in any of the operations performed by the various surgeons who have undertaken them"; and the only losses likely to occur, he intimates, are from blunders and awkwardness. He is particularly at pains to demonstrate that no danger of peritonitis, so much feared by physicians, is incurred in it. A great deal, however, is acknowledged to depend on the proper selection of cases to be operated upon. Heaton's great success may be largely ascribed to the discrimination he exercised in this matter, and we are told that "when speaking of his invariable success, he was in the habit of giving me a peculiar wise and knowing look of the eye, and he would say that he cured all, or about all, that he *would* operate on." The general health of the patient has, of course, much to do with the success of the operation, and something depends on the kind of hernia. The succeeding chapters to those on operations are devoted to the treatment of strangulated hernia, kelotomy, or herniotomy, "Artificial Anus and Wounds of the Intestines," hydrocele and varicocele, some observations on trusses which might be made of general application, copious accounts of cases, an extensive bibliography, and a list of operators. The work is presented by the publishers in excellent shape, with the best of paper and print, and an abundance of clearly delineated illustrations.

PROCEEDINGS OF THE BIOLOGICAL SOCIETY OF WASHINGTON. Vol. I. Washington: Printed for the Society. (G. Brown Goode, Secretary.) Pp. 110.

THIS volume contains the constitution of the society, the list of honorary, corresponding, and active members, and the proceedings from the first meeting, for organization, November 19, 1880, to May 26, 1882. In addition are given in full the addresses delivered on the occasion of the Darwin Memorial Meeting, May 12, 1882, comprising "The Doctrine of Darwin," by Theodore Gill; a "Biographical Sketch," by William H. Dall; "Darwin's Work in Entomology," by Dr. Riley; "Darwin as a Botanist," by Lester F. Ward; "Darwin on the Expression of the Emotions," by Frank Baker, M. D.; and "A Darwinian Bibliography," by Frederick W. True. President Gill's inaugural address of 1881, on "The Proper Use of the Term Biology," is also published in full.

A Guide to Modern English History. By William Cory. Part II, 1830 to 1835. New York: Henry Holt & Co. Pp. 567. Price, $3.50.

The first part of this work related to the first fifteen years of the great peace. The expansion of the present volume, which includes only about a third as much time, is justified by the author, on the ground of the "excessive value of the work done for the British Commonwealth in the years now surveyed." These years, the author adds, "are full of the virtue and wisdom which make modern England supremely worthy of a student's contemplation; it seems not too much to say that they form a period of paramount importance in the history of legislation and government." The work is the composition of a sharp observer, and is marked by vigorous thought and forcible expression, and a bold, captivating style that engages the reader and holds him. Mr. Samuel R. Gardiner, who may be regarded as an expert in the specialty of English history, characterizes it as "one not very well calculated to guide those who do not know a good deal of the way already, but admirably fitted to enable those who do to test those opinions which they have sometimes too hastily formed."

Address delivered by Edward Atkinson at the Opening of the Second Annual Fair of the New England Manufacturers' and Mechanics' Institute in Boston, September, 6, 1882. Pp. 32.

The end to be subserved by such industrial exhibitions, Mr. Atkinson tells us, is to make less arduous the daily work whereby the larger part of the community earn their daily bread. The author is not one who takes a pessimist's view of life, and, although he shows that the measure of comfort that each man, woman, and child can yet enjoy, even in our prosperous land, does not exceed on an average fifty or sixty cents per day, he does not think or believe that increase of wealth is of necessity complemented by increase of poverty. Still the small minority of people who can become possessors of capital in any large measure must justify the leisure which they or their fathers have earned, by the use which they make of the time and means at their disposal. After showing how it is possible for our railroad kings to put money in our pockets while amassing fortunes themselves, he compares our happy lot with the unfortunate condition, from an economic point of view, of those countries that are burdened by huge standing armies, and where the quantity produced, although relatively less, must be divided among a greater number. The advantages of developing the hand and brain together are then referred to. The last man or woman whom you desire to discharge from the works which you control, when the times are hard, is the one earning the most for himself or herself; the first to be discharged is the unfortunate one whose hand and brain have not been developed together, and who can, in hard times, no longer render you a service, even if paid a sum barely sufficient to support life. "Owing to the great natural, social, and political advantages that we enjoy, the wages of labor and the remuneration of capital must be greater in proportion to the effort used than in any other section of the world's surface; and these facts prove that the cost of production is less in ratio to product than it can be anywhere else."

Although intended for delivery before a limited audience on a particular occasion, the address is of such general interest as to deserve a wide circulation.

Contributions to Mineralogy. By F. A. Genth. Read before the American Philosophical Society, August 18, 1882.

This pamphlet of twenty-four finely-printed pages represents a large amount of actual labor, and contains several important contributions to science, in the form of analyses and observations on altered minerals. That one mineral should be gradually changed, particle by particle, molecule by molecule, into a different mineral having other chemical and physical properties, is a curious and interesting phenomenon, worthy the study of such a chemist as Professor Genth. The first case described is the alteration of corundum, in Madison County, North Carolina; it is found partially altered to a massive greenish-black spinel; in Towns County, Georgia, a pink corundum is found surrounded by greenish-white, cleavable zoisite; an interesting occurrence of the alteration of corundum into a feldspar is near Media, Pennsylvania, at the "Black-

Horse" tavern; Haywood County, North Carolina, has furnished specimens of corundum altered into feldspar, as well as mica; examples of corundum altered into margarite (calcium mica), cases of the alteration of corundum into fibrolite and cyanite are also mentioned. The altered minerals were more or less water-worn and rounded, while the corundum which they inclose is sharp and angular, which proves that since the great gravel deposits were formed no alteration of the corundum has taken place in these deposits.

The other interesting alterations described by Professor Genth are the alteration of orthoclase into albite, and talc into anthophyllite, and pseudomorphs of talc after magnetite. Several other investigations of mineral species follow, among them gahnite, rutile and zircon, sphalerite and prehnite, pyrophyllite, beryl, niccolite, and artificial alisonite. The author also describes the accidental formation of artificial crystals of rutile during fusion with potassium hydrogen sulphate; two crystals of octahedrite were likewise produced at the same time, and had a decided blue color.

ON THE AGE OF THE TEJON ROCKS OF CALIFORNIA, AND THE OCCURRENCE OF AMMONITIC REMAINS IN TERTIARY DEPOSITS. By ANGELO HEILPRIN. From "Proceedings of the Academy of Natural Sciences of Philadelphia," July, 1882.

THE author undertakes to settle the point in dispute between Conrad and Gabb, as to the age of the Tejon rocks, referred by the former to the Eocene series, and by the latter to the Cretaceous. A list of one hundred and twelve species is given, representing the fauna of the Tejon group with the various localities of occurrence, as claimed by Gabb, and evidence presented to show that Gabb was in error in many cases, and hence that the tables do not afford a safe criterion for the solution of the problem. The author then goes on to show that, of the seventy-seven genera represented in the Tejon group, at the very least twenty-two are more or less distinctively Tertiary, and out of these eleven are not positively known to have appeared before that geological epoch. Also that, with the exception of six or seven fragments of *Ammonitidæ*, there is not a single distinctively Cretaceous generic type in the entire number. He therefore concludes that the rocks of the Tejon group, despite their comprising in their contained faunas a limited number of forms from the subjacent (cretaceous) deposits, and a few undoubted representatives of the *Ammonitidæ*, are of Tertiary (Eocene) age.

The Eocene age of the Tejon rocks is likewise maintained by Professor Jules Marcon, who made a personal examination of the region.

PROCEEDINGS OF THE DAVENPORT ACADEMY OF NATURAL SCIENCES. Vol. III, Part II. Davenport, Iowa: Published by the Academy. Pp. 192, with Four Plates.

THE present number contains the proceedings of the Academy during 1879 and 1880, with the president's addresses of Mrs. M. L. D. Putnam and Mr. W. H. Pratt. The numerous papers testify to the great activity of the members of the Academy in the leading departments of investigation, predominantly in archæology, to the study of which the location of the society offers excellent facilities. A very interesting paper is that of Professor G. Seyffarth on the inscriptions of the Davenport Tablets, the conclusions of which are startling for their boldness.

HOW TO SUCCEED: A Series of Essays by Various Authors. Edited by the Rev. LYMAN ABBOTT, D. D. New York: G. P. Putnam's Sons. Pp. 131. Price, 50 cents.

THIS is a republication of a series of papers which appeared last winter in the "Christian Union," on the general subject and its applications, headed with articles by Senators Bayard and Edmunds on "Success in Public Life," and continued with other articles, by men who have attained eminence in their various professions or arts, on the elements of success in their respective callings.

CEREBRAL HYPERÆMIA: DOES IT EXIST? A Consideration of some Views of Dr. William A. Hammond. By C. F. BUCKLEY, B. A., M. D., formerly Superintendent of Haydock Lodge Asylum, England. New York: G. P. Putnam's Sons. Pp. 129.

THE author opposes the theory which Dr. Hammond has published concerning the effects of excess or deficiency of blood in

the brain with an earnestness which it is safe to call extreme. He assails with controversial ardor the logic of Dr. Hammond's views, and endeavors to show that they are inconsistent with themselves, and are not supported by the facts whence they are drawn, or by the authors from whose works Dr. Hammond has endeavored to substantiate particular points of his theory.

THE SOLUTION OF THE PYRAMID PROBLEM, OR PYRAMID DISCOVERIES, WITH A NEW THEORY AS TO THEIR ANCIENT USE. By ROBERT BALLARD, of Queensland. New York: John Wiley & Sons. 1882. Pp. 109.

MR. BALLARD is not the first who has advanced a theory as to the purpose for which the pyramids were built, nor even the first to conjecture that they were of use in resurveying the land after the annual inundations of the Nile. "Built by scientific men, well versed in geometry, these great stone monuments are so suited in shape for the purposes of land-surveying, that the practical engineer or surveyor must, after consideration, admit that they may have been built mainly for this purpose." The author also thinks that he has discovered the unit of measure used in their construction, and to which he gives the name of Royal Babylonian cubit. This cubit he makes equal to 20·22 British inches, and as there are 77,760,000 royal Babylonian cubits to the polar circumference of the earth, the cubit represents the $\frac{1}{10}$ of a second. This he claims is the most perfect ancient measure yet discovered. It is a perfect, natural, and convenient measure which fits the plan of the pyramids and fits the circumference of the earth. The author also states that the pyramid of Cheops is situated on one acute angle of a right-angled triangle, and the pyramid called Mycerinus is on the other acute angle, the other two sides of which run respectively east and south from these pyramids. The sides of this triangle are respectively 3, 4, and 5. The pyramids of Cheops and Cephren are situated on the acute angles of a still more remarkable triangle, the sides of which are to each other as 20, 21, and 29. Many other curious facts are mentioned regarding the dimensions, position, and slope of the pyramids, and a description of the method in which the author supposes them to have been used as the "theodolites of the Egyptians." Many of the obelisks, he thinks, were probably marks on pyramid lines of survey, and the pyramid may have been a development of the obelisk for this purpose.

A GUIDE TO COLLODIO-ETCHING. By BENJAMIN HARTLEY. Illustrated by the author. New York: The Industrial Publication Company. Pp. 48, with Six Plates.

THIS little work is for the benefit of amateurs, who feel the need of some simple and inexpensive method of duplicating their sketches and studies for the benefit of their friends. The various methods by lithography, photography, and the photo-engraving of pen-and-ink drawings which have been suggested by different persons, have been found by the author to be inconvenient, expensive, and troublesome. He describes, as more nearly realizing than any other one the conditions required by the amateur, a process for drawing the sketch with a needle upon the glass plate, as prepared by the photographer for the camera, and printing from the etching as an ordinary photograph is printed. He undertakes to give all the practical information necessary on the subject, so that persons who know nothing about photography may be able to carry into effect all the details of his system.

UNITED STATES COMMISSION OF FISH AND FISHERIES. Report of the Commissioner for 1879. Washington: Government Printing-Office. Pp. 846.

THE report embraces an inquiry into the history and statistics of food-fishes, and a summary of what has been accomplished in the matter of their propagation in the waters of the United States. Among the collateral subjects of attention by the commission have been an investigation into the chemical composition of fish under the varying circumstances of age, sex, and the condition of the reproductive apparatus; researches into the temperature of fishes, experiments in the production of cold for the preservation of fish, and the preparation of a series of casts in plaster and *papier-maché* of the larger species. The pole-flounder, which was discovered off the coast of New England in 1877, proves to be one

of the most abundant of the flat-fish family, and promises to be an important addition to the food resources of the country. A second species of fish, known as the tile-fish, and constituting a genus and species entirely new to science, was discovered during the summer of 1879. The most important item of the year in the work of propagation was the beginning of the distribution of young carp to various points in the United States. The demand for the fish was very great, even with a relatively small supply, and the calls increased so rapidly that it became doubtful whether, even with a much larger production, all the requirements could be met. Good progress is reported in the propagation and distribution of salmon and trout of the various species, shad, codfish, and striped bass. Among the valuable papers with which the report proper is supplemented are one by Professor W. G. Farlow, on the "Marine Algæ of New England," containing technical descriptions of all the known species; an account of the cephalopods of the north-eastern coast of America, by A. E. Verrill; and articles on the propagation of the eel, the food of marine animals, the Iceland herring fisheries, the periodicity of the great herring-fisheries, the herring's mode of life, the fisheries of the west coast of South America, the scientific examination of the German seas, the effects of sawdust and the pollution of waters by factory refuse on fishes; and articles and reports bearing upon more special features of fish propagation.

THE GULF STREAM. Additional Data from the Investigations of the Coast and Geodetic Steamer Blake. By Commander J. R. BARTLETT. Pp. 16.

THIS publication embodies the substance of a paper which was read by the author before the American Geographical Society, and is supplementary to a previous paper. The author states that he is "not hampered with any theories," and merely gives his deductions from the actual facts obtained by the Blake's party, which may serve to correct a few popular errors, even if they do not throw much new light on the subject. His principal conclusions have already been noticed in "The Popular Science Monthly."

PROCEEDINGS OF THE DEPARTMENT OF SUPERINTENDENCE OF THE NATIONAL EDUCATIONAL ASSOCIATION, March 21 to 23, 1882. Washington: Government Printing-Office. Pp. 112.

VALUE is added to the report of the ordinary discussions of this body by the papers of Drs. Billings and Charles Smart relating to "Ventilation"; of the Hon. H. S. Jones on "Obstacles in the Way of a Better Primary Education"; of Professor G. Stanley Hall on "Chairs of Pedagogy in our Higher Institutions of Learning"; of Drs. A. D. Mayo and J. L. M. Curry on "National Aid to Education"; of Dr. Sheldon Jackson on "Education (or the Want of it) in Alaska"; of Dr. John M. Gregory on the "Common-School Studies."

PUTNAM'S ART HAND-BOOKS. Edited by SUSAN N. CARTER. DRAWING IN BLACK-AND-WHITE. — SKETCHING IN WATER-COLORS. New York: G. P. Putnam's Sons. Pp. 55 and 69. Price, 50 cents each.

THE first manual, by the editor, is an effort to show beginners "why they had best choose one material in black-and-white, or another; and to tell them, by a few plain directions, how they can best manage their charcoals, crayons, pen-and-ink, or lead-pencils." The directions are clear, and are complemented by typical illustrations, from masters, in each of the styles; but it would be better, perhaps, if the directions and illustrations were more conformed to each other. The second book is by Thomas Hatton, and is intended for the use of such students "as are accustomed to copy water-color drawings, and find no difficulty in sketching natural objects in black-and-white," yet need the instructions it undertakes to give them, to enable them to reproduce Nature expressively in her own colors.

A DICTIONARY OF MUSIC AND MUSICIANS. Edited by GEORGE GROVE, D. C. L. Parts XV and XVI (Double Part). London and New York: Macmillan & Co. Pp. 272. Price, $2.

WE have already called attention to the fullness and the other merits of this excellent work. The present double number contains the articles under the titles from "Schoberlechner" to "Sketches."

THE "Hoffman Cover and Binder" is a very useful aid for the convenient handling and preservation of magazines and pamphlets while in use and afterward. It is a well-finished book-cover, so arranged that a magazine can be placed and fastened within it in a moment, so as to form a substantial bound book; then, when the next number arrives, can be taken out and replaced by the new one; or it can be left in and deposited as a single volume in the library. The magazine is thus kept in perfect order, whether it is intended to be bound with its fellow-numbers or filed singly. Six sizes are kept in stock, to accommodate the variously shaped publications from "The Popular Science Monthly" to "Harper's Weekly" or the "Illustrated London News," and other sizes will be furnished to order, by Joseph A. Hoffman, 208 Montgomery Street, San Francisco.

"THE American Journal of Physiology" is a new monthly periodical, each number of which will consist of sixteen pages, edited and published by D. H. Fernandes, M. D., Indianapolis, Indiana. It is intended to supply what the editor believes to be a lack in American scientific literature, and is promised communications from several prominent specialists.

"THE Modern Stenographic Journal" is a new Phonographic Magazine, published at Buffalo, New York, by George H. Thornton, editor, and Emory P. Close, associate editor. It will keep its readers in the current of what is going on in the stenographic world; will contain a department of instruction, with serial lessons, and a department devoted to the type-writer and calligraph; and will endeavor to popularize "a simple and rapid system of writing."

PUBLICATIONS RECEIVED.

Address before Section B (Physics) of the American Association for the Advancement of Science, at the Montreal Meeting. By T. C. Mendenhall. Salem, Mass., 1882. Pp. 14.

Test of Building Material, made at Watertown Arsenal, Mass., August, 1882. Philadelphia, 1882. Pp. 33.

Aberrations of Audibility of Fog-Signals. By Arnold B. Johnson. Washington: Judd & Detweiler, Printers. 1882. Pp. 14, with Two Maps.

The Longfellow Calendar for 1883, with Selections for Every Day in the Year. Boston: Houghton, Mifflin & Co.

Statement of Work done at the Harvard College Observatory during the Years 1877-1882. Pp. 23; and, A Plan for securing Observations of the Variable Stars. Pp. 15. By Edward C. Pickering. Cambridge: John Wilson & Son, 1882.

The Worship of the Reciprocal Principles of Nature among the Ancient Hebrews. By J. P. MacLean. Cincinnati: Robert Clarke & Co. 1882. Pp. 23. 25 cents.

Seventh Annual Report of Johns Hopkins University. Baltimore, Md. 1882. Pp. 129.

"Paleontological Bulletin," No. 35. By Professor E. D. Cope. Philadelphia: A. E. Foote. 1882. Pp. 44.

Northern Transcontinental Survey. First Annual Report of Raphael Pumpelly, Director. New York: Wells Sackett & Hankin, Printers. 1882. Pp. 16.

Some Observations on Ostriches and Ostrich-Farming. Pp. 11.

Some Indications of an Early Race of Men in New England. By Henry W. Haynes. From the "Proceedings of the Boston Society of Natural History." Pp. 9.

On the Determination of the Flashing Point of Petroleum. By John T. Stoddard. Pp. 4.

Radiant Heat an Exception to the Second Law of Thermo-Dynamics. By H. T. Eddy, Ph. D. 1882. Pp. 10.

The Sense of Dizziness in Deaf-Mutes. By William James, M. D. Cambridge, 1882. Pp. 16.

Transactions of the Anthropological Society of Washington. From February, 1879, to January, 1882. Vol. I. Washington, 1882. Pp. 142.

Food Adulterations. By Professor Albert B. Prescott, M. D. Reprint from "Annual Report of Michigan State Board of Health for 1882." Pp. 6.

The Tides. By John Nader, Civil Engineer. 1879. Pp. 31.

Sketch of Lewis H. Morgan. By F. W. Putnam. From the "Proceedings of the American Academy of Arts and Sciences," May, 1882. Pp. 8.

Facts and Phases of Animal Life. By Vernon S. Morwood. Illustrated. New York: D. Appleton & Co. Pp. 286. Price, $1.50.

Winners in Life's Race; or, The Great Backboned Family. By Arabella B. Buckley. Illustrated. New York: D. Appleton & Co. Pp. 367. Price, $1.50.

Lectures on Art, delivered in Support of the Society for the Protection of Ancient Buildings. By Reginald Stuart Poole and others. London: Macmillan & Co. Pp. 232. Price, $1.50.

Anatomical Technology as applied to the Domestic Cat. An Introduction to Human, Vertebrate, and Comparative Anatomy. By Burt G. Wilder and Simon H. Gage. New York and Chicago: A. S. Barnes & Co. Pp. 575. Price, $4.50.

The Life of James Clerk Maxwell, with a Selection from his Correspondence and Occasional Writings, and a Sketch of his Contributions to Science. By Lewis Campbell and William Garnett. London: Macmillan & Co. Pp. 662. Price, $6.

New Method of Learning the French Language. By F. Berger. New York: D. Appleton & Co. Pp. 138. Price, $1.

A Study, with Notes, of "The Princess" (Tennyson's poem). By S. E. Dawson. Montreal: Dawson Brothers. Pp. 190.

American Hero-Myths: A Study in the Native Religions of the Western Continent. By Daniel G. Brinton, M. D. Philadelphia: H. C. Watts & Co. Pp. 251. Price, $1.75.

Traits of Representative Men. By George W. Bungay. Illustrated. New York: Fowler & Wells. Pp. 286. Price, $1.50.

Charles Darwin. Memorial Notices, reprinted from "Nature." London: Macmillan & Co. Pp. 82. Price, 75 cents.

A Whimsical Wooing. By Anton Giulio Barili. From the Italian by Clara Bell. New York: William S. Gottsberger. Pp. 88.

Experimental Physiology. Its Benefits to Mankind. By Richard Owen, C. B., M. D., F. R. S., etc. London: Longmans, Green & Co. Pp. 216. Price, five shillings.

Youth: Its Care and Culture. By J. Mortimer Granville. New York: M. A. Holbrook & Co. Pp. 167.

The Scientific and Technical Reader. London: T. Nelson & Sons. Pp. 400. Price, 2*s.* 6*d.*

The Factors of Civilization, Real and Assumed. Considered in their Relation to Vice, Misery, Happiness, Unhappiness, and Progress. Vol. II. Atlanta, Georgia; James P. Harrison & Co. Pp. 359.

Text-Book of Geology. By Archibald Geikie. London: Macmillan & Co. Pp. 971. Price, $7.50.

The Coues Check-List of North American Birds. Second edition. Boston: Estes & Lauriat. Pp. 165.

The Diseases of the Liver, with and without Jaundice. By George Harley, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 751. Price, $5.

Novissimum Organon: The Certainties, Guesses, and Observations of John Thinking-machine. By James Ferdinand Mallinckrodt. St. Louis: Hugh R. Hildreth Printing Co. Pp. 116.

Quintus Claudius: A Romance of Imperial Rome. By Ernst Eckstein. From the German by Clara Bell. In two vols. New York: William S. Gottsberger. Pp. 616. Price, $1.75.

Dress and Care of the Feet. By Dr. P. Kahler. New York: G. P. Putnam's Sons. Pp. 89.

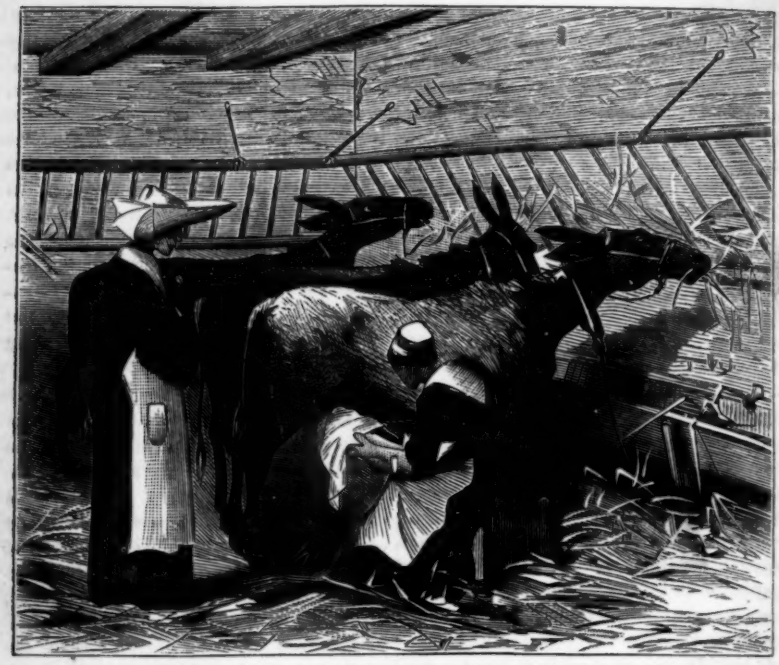
POPULAR MISCELLANY.

Mortality in Town and Country.—Professor Finkelnburg attempted to show, in a paper read at the recent Sanitary Congress in Cologne, that cities are not of necessity less healthy than country districts, and that, where they appear to be so, the fact can generally be attributed to local influences affecting the hygienic or economical condition of the population. The analysis and comparison of adult male and female mortality and infant mortality bring out many interesting facts. The male population of the cities is described as being less healthy than the female population, and liable to consumption and affections of the heart, brain, and kidneys. In Cologne, the mortality among women over thirty years of age is not only less than among men, but is less than the death-rate among women of the same ages in other parts of the Cologne district. Similar results are shown at Bonn. The deaths of men from consumption show a marked predominance in the centers of the textile and metal industries. The fact that a similar result appears in country districts where labor of a similar character is carried on is presumptive evidence that the mortality is associated with the industrial activity of the towns. Epidemic diseases seem to show an excessive urban mortality only in the case of young children. Infant mortality appears to reach its highest point where the population is most dense, and the proportion of female labor in the factories is most considerable. A more favorable condition, however, seems to prevail in those districts where domestic labor is general. It is proved with a certain amount of clearness that infant mortality varies according to the dwelling accommodation in towns and the amount of parental care which circumstances permit. This result is not a sure guide as to all diseases, for which diarrhœa and similar disorders contribute a notable proportion to urban mortality in general; deaths from diphtheria and whooping-cough in the Rhine provinces are more numerous in the country than in the towns. Professor Finkelnburg also notices that the mortality in cities increases in the summer and fall, while the increase in the country takes place during the winter and spring.

Indians of the Hudson Bay Territory.—Dr. John Rae has furnished the Society of Arts with some information about the native tribes of the Hudson Bay Company's Territories, which is all the more valuable because it is thirty years or more old; for it brings us nearer to the original condition of the tribes before they were affected as much as they are now by intercourse with the white men. Dr. Rae divides the native tribes of the Territory into the Innuits, or Esquimaux, of the Arctic seaboard down to Labrador; the Dené Dindjié, eleven tribes east of the Rocky Mountains and south of the Esquimaux; the Algonquins, twelve tribes; and the Hurons-Iroquois, of Lake Huron, the Ottawa River, and the Province of Quebec. The Wood Crees, one of the principal tribes on Hudson Bay, are a fine, docile race, with comparatively few faults, and these injurious only to themselves. They are very fond of strong drinks, and have a great dislike to agricultural labor on their own account, although they work very well for

others when paid for it. They make their living by hunting wild fowl and animals, of which the most valuable to them appears to be the rabbit. Their clothing was chiefly made of rabbit and reindeer-skins before they came in contact with the white men. Rabbit-skins sewed together make the warmest of blankets, even though the fingers may be pushed through them anywhere, and an Indian child dressed up in them, like "baby bunting," is a funny-looking but very cozy creature. The Indian babies seem never to cry, never to squall, as more civilized babies are in the habit of doing, and are never chastised. "It would be thought very unnatural and cruel in a mother to flog or strike her child." All the Indians treat with much ceremony and respect the body of any bear they may have killed. He is placed in a sitting posture against a tree, and long speeches are made of apology and regret for having been under the disagreeable necessity of killing him. Then, as the bear may come to life again even after he has been disemboweled, a stick is put into his mouth to keep it wide open, and a profuse and humble apology is made to him for the additional indignity. The supposed necessity for this precaution is believed to have arisen from the fact that a bear, thought to be dead, came to life again while being carried home, and took a mouthful out of one of his Indian bearers. With a small tribe called the Dog-ribs, or slaves, the custom prevails of wrestling for the right to a wife, "the lady sitting by, an apparently careless and indifferent spectator of the struggle for possession. No other ceremony is required than that the victor, whether her former husband or not, claims his wife." Another custom, and an unfortunate one, is that on the death of a near relative these Indians must destroy every article of property of value that they possess, excepting perhaps an old deer-skin robe and a few other articles. They, moreover, can not hunt during the season in which the loss occurs, and are thus exposed to great poverty. With nearly all the Indians, a certain favorite piece of deer or bird is tabooed to the women, and they dare not taste it, or even come near where it is cooking, under a severe penalty. With the Chippewas it is the moose-nose, with the Wood Crees some part of the wild-goose, and with the Dog-ribs the reindeer head. A peculiarity of the Hudson Bay Company's tariff, which has been considerably misrepresented, is that far higher prices, in proportion to their value, are paid to the Indians for inferior furs than for the finer ones. The object of this regulation is simply to prevent the undue hunting of the more expensive furs. "I fear," says Dr. Rae, "that little can be done for these northern Indians, unless they can be reasoned out of their prejudices and superstitions, which, with their imprudences and wastefulness, are the cause of their being so poor."

Ass's Milk for Infants.—M. Parrot, physician at the Hospital for Assisted Children in Paris, has recently made a report of the success which has attended the efforts he has made to introduce an improved system of alimentation into the nursery of that institution. His conclusions, confirmed as they are by the observations of his colleague, M. Tarnier, who had the charge of an important class of young nurses, deserve the particular attention of hospital and municipal administrations. Good nurses are very scarce, and it is hard to keep a strict watch upon the children consigned by the public charities to their care. On the other hand, a goodly number of these poor little ones come into the world afflicted with diseases which forbid their being committed to a nurse, because they would be in danger of infecting her. At the Children's Hospital, where the proportion of these wretched infants is always considerable, it has been found necessary to feed them from the bottle in the halls of the infirmary. Notwithstanding the most intelligent care, this means has not been efficient to restore the strength of the infants, who were, in fact, nearly moribund with disease contracted in their mother's womb. M. Parrot had a single chance to save them and tried it; it was to nurse them directly at the teat of an animal. The nursery which has been established in the gardens of the Hospital for Assisted Children has been in operation for about a year, and the results of the experiments have been so satisfactory that no reason exists for waiting for a longer trial before making them known. In the face



Ass's Milk Nursery at the Hospital for Assisted Children, Paris.

of the preliminary difficulties in personal instruction and the insufficient number of animals at the disposal of the hospital, the rate of mortality has been greatly reduced. The infants were at first fed with goat's milk, but it was soon found that ass's milk was better for them; and they are now all fed with milk which they draw directly from the teat of the animal. One, two, and sometimes three children are presented to the ass at the same time, being held at the teat in the arms of the nurse, and the operation is performed with wonderful ease. Numbers speak most eloquently of the success of the method. During six months, eighty-six children afflicted with congenital and contagious diseases were fed at the nursery. The first six were fed, by stress of particular circumstances, with cow's milk from the bottle; only one of them recovered. Forty-two were nursed at the teat of the goat; eight recovered, thirty-four died. Thirty-eight were nursed at the teat of the ass; twenty-eight recovered, ten died. In the face of such results there can be hardly any hesitation in declaring that in hospitals, at least, the best method of feeding newborn children, who can not, for any reason, be confided to a nurse, is to put them to suck directly from the teat of an ass. The virtues of ass's milk have not waited for recognition till this late day. Paris and other large cities have, for many years, enjoyed the visits of troops of asses which have been brought in to supply the restorative liquid to the sick and feeble. If we may credit the legend, the use of this milk was introduced into France during the reign of Francis I. That brave monarch had fallen into a state of extreme exhaustion, in consequence of his over-exertion in military and other exercises. His physicians not being able to produce any change in his condition, a Jew was brought from Constantinople, who prescribed simply a beverage of ass's milk; he took it, according to the chronicle, and became better. Ass's milk owes the advantages which it possesses over that of goats to its chemical composition, the distinguishing feature of which is that it contains less plastic substance and butter than goat's milk. Like mother's milk, it

forms a precipitate of little isolated flakes easily soluble in an excess of gastric juice. It does not load the stomach of the sickly and puny infants, who ought to be spared all possible difficulty in digestion. Mare's milk would be, if it were easy to get, a still better substitute for mother's milk. It has nearly the same composition, and M. Berling, a Russian physician who has tried it, has found in it all the qualities necessary to sustain new-born children.

Aborigines of the Isthmus.—Mr. E. G. Barney has given in the "American Antiquarian" an account of the history and present condition of the native races of the United States of Colombia. The territory of that republic, now divided into nine States and six Territories, was inhabited at the time of the discovery and conquest, from 1498 to 1545, by a dense population, which was variously estimated at from eight million to twenty million souls. The inhabitants of the State of Panama were in various stages of advancement, "from dwellers in the tree-tops to a degree of civilization very much superior to that of Britain at the time of the Roman conquest, or indeed at the time the Saxons ruled the island." Columbus in one of his letters speaks of his brother having seen a house devoted to the dead, and containing many well-embalmed bodies, over which were wooden slabs engraved with the figures of various animals, and one bearing a good portrait of the deceased. During a journey in the interior, this brother found a dense population, entirely agricultural, and passed at one place eighteen miles through continued fields of corn. The inhabitants of the coasts and islands wore little clothing, but valuable ornaments of gold, and these appear to have been imported from other states, being bought for gold-dust, dried fish, and products of the soil. Balboa and his forces were entertained in the spacious house of a cacique, in one of the rooms of which were kept the embalmed ancestors of the chief for many generations, and which was surrounded by large grounds with towering palm-trees and gardens and orchards. These people, who appear to have compared favorably with most European nations before the invention of gunpowder, are believed to have been of the same race with the North American Indians, but agricultural in their habits. Their weapons of war were bows and arrows, darts, lances, war-clubs, etc. Their implements of husbandry were stone axes and sharpened sticks hardened in the fire, and their mills were smooth stones, rubbed together with the hand. Their nets for fishing were made of the fibers of the *Agave Americana*, and their hooks were made from turtle-shells. On the head-waters of some of the tributaries of the Atrato "were found one tribe of very skillful artisans in golden ornaments; another equally skillful in spinning and weaving cotton cloths, nets, hammocks, etc., the former being very tastefully colored; and another tribe adjacent were agriculturists, but showed unusual taste in adorning the surroundings of their homes with gardens, fruit-orchards, etc. One tomb is mentioned as having been artistically constructed, from which the sum of forty thousand dollars was taken by César and his party. . . . These tribes are said to have had *adoratorios*, and a system of religious belief too variously stated to enable me to form any opinion of its character." In the upper valley of the Cauca, on the slopes and valleys of two immense mountain-ranges, dwelt many tribes, either wholly agriculturists or partly agriculturists and partly fishermen, or manufacturers of salt, golden ornaments, or cotton cloth, etc. Many of the tribes in this valley were considerably advanced in culture; some had the streets of their towns wide and regular; some were manufacturers of cotton goods; one manufactured golden ornaments, and two made salt by boiling down saline waters. It cost much Castilian blood to subdue these people, but, finding that they could not contend against the superior weapons of the Europeans, they generally refused to plant, and in two years the Spaniards were compelled to begin to introduce negroes to till the ground so lately occupied by a happy and contented people. "Along the eastern side of the Gulf of Darien and along the northern slopes of the Abibe, the descendants of the independent tribes, whose poisoned arrows defeated nearly every attempt to penetrate their country, still hold their native land as free from the intruder as when the European

invader first attempted its conquest. . . . An infinity" of mounds was found in one locality, and twenty-four human figures in wood in one of the temples, and golden bells outside, "which gave out sweet chimes in ever-varying tones." Some of the mounds contained ornaments, in imitation of every form of life, from the ant to a human being, and of every value from $10 to $30,000.

Waste of the World's Forests.—When the forests of such a country as Cyprus were destroyed, said Mr. Thistelton Dyer in a discussion in the British Society of Arts, it was like a burned cinder. Many of the West Indian Islands are in much the same condition, and the rate with which the destruction takes place when once commenced is almost incredible. In the Island of Mauritius, in 1835, about three fourths of the soil was in the condition of primeval forest, viz., 300,000 acres; in 1879, the acreage of woods was reduced to 70,000; and in the next year, when an exact survey was made by an Indian forest officer, he stated that the only forest worth speaking about was 35,000 acres. Sir William Gregory says that in Ceylon, the eye, looking from the top of a mountain in the center of the island, ranged in every direction over an unbroken extent of forest. Six years later the whole forest had disappeared. The denudation of the forests is accompanied by a deterioration in the soil; and the Rev. R. Abbay, who went to Ceylon on the eclipse expedition, calculated, from the percentage of solid matter in a stream, that one third of an inch per annum was being washed away from the cultivated surface of the island. In some colonies the timber was being destroyed at such a rate as would soon lead to economic difficulties. In Jamaica, nearly all the timber required for building purposes has already to be imported. In New Brunswick, the hemlock-spruce is rapidly disappearing, one manufacturer in Boiestown using the bark of one hundred thousand trees every year for tanning. In Demerara, one of the most important and valuable trees, the greenheart, is in a fair way of being exterminated. They actually cut down small saplings to make rollers on which to roll the large trunks. In New Zealand, Captain Walker says he fears that the present generation will see the extermination of the Kauri pine, one of the most important trees. All these facts show that this is a most urgent question, which at no distant date will have to be vigorously dealt with.

Professor Huggins on Comets.—Professor Huggins endeavored, in a recent lecture on comets, to distinguish as clearly as possible between what we know about those bodies, and what is only speculation. Some comets have become permanent members of our system, while others probably visit us once only, never to return. It depends upon a comet's velocity whether its orbit shall take the shape of a returning curve or not. If the velocity, at the earth's distance from the sun, exceeds twenty-six miles a second, the comet will go off into space, never to come back to us. The small portion of the comet's life during which we are able to study it—when it is in a condition of extreme excitement, in consequence of its nearness to the sun—is quite unlike its ordinary humdrum existence, when it has only a nucleus and no tail. Spectroscopic observations of comets show that they shine with an original light, the bands of which indicate a composition of carbon combined with hydrogen, and also with a reflected light, the lines of which indicate the presence of a nitrogen compound of carbon. Moreover, "certain minor modifications of the common type of spectrum are often present, and show, as was to be expected, that the conditions prevailing in different comets, and, indeed, in any one comet from day to day, are not rigidly uniform." The study of meteorites, Mr. Huggins suggests, may throw some light on the constitution of the nuclei of comets, which are probably similar to them, and therefore solid. The tails have been supposed to be gaseous matter sent off by the sun's repulsive action. The gases are probably not products of decomposition, but matter that has been occluded. Experiments so far throw little light on the question whether cyanogen is present in combination or otherwise within the comet, or whether it is found at the time by the interaction of carbonaceous and nitrogenous matter. In the latter case we should have to admit a high temperature,

which would be in favor of the view of an electric origin of the comet's light. The curved forms of the tails of comets, and their greater density on the convex side, admit of explanation on the supposition that they are matter repelled from the sun. On this hypothesis, also, a comet would suffer, of course, a large waste of material at each return to perihelion, since the nucleus would be unable to gather up again to itself the scattered matter of the tail; and this view is in accordance with the fact that no comet of short period has a tail of any considerable magnitude. There seems to be a rapidly growing feeling among physicists that both the self-light of comets and the phenomena of their tails belong to the order of electrical manifestations.

The Sunken Southern Continent again.—The French Academy of Sciences recently had before it the question of the former existence of the hypothetical Southern Continent. M. Émile Blanchard presented the condition of living faunas and floras as affording evidence of the former existence of such a continent. Additional proof was suggested by the examination of the charts of the sea-depths, which show that the whole region where the lands that may be regarded as the remains of a continent are located is one of comparatively shallow water; beyond this space, the seas are very deep. The large accumulations of remains of moas that are observed in small districts indicate that an enormous number of those gigantic birds must have existed in New Zealand at no very remote period. It is hard to believe that their extinction can have been brought about by the Maories, never very numerous. Physical events must probably have been the primary cause of their destruction. While they were scattered over an extensive territory, their existence was easy; as the land sunk from under them, they had to take refuge in the spaces that remained above water. Under the new conditions the moas would have perished by hundreds wherever they became crowded together in too great numbers. Thus the extinction of these birds lends further probability to the hypothesis of the sinking of a southern continent. We are still without sufficient information respecting the floras, especially do we lack precise knowledge of the entomological fauna of the little islands which are suspected of being the remains of a continent. M. Alphonse Milne-Edwards remarked that it seemed hard to believe that the Mascarene Islands, small as they are, and apparently so little favorable to the vigor of their respective faunas, can each have been the cradle of species so well characterized and so different from those that exist elsewhere. More probably each of the volcanic cones constituting the nucleus of those islands existed before the lands were sunk to a considerable extent, and served as the last refuge for the now extinct zoölogical population of the neighboring region. This fauna has such points of resemblance with those of New Zealand and other parts of the Antarctic region, that we can not hesitate to class it with the Austral faunas. It may, thus, possibly have extended farther south. We are thus brought to the idea of a great land formerly existing in the part of the Atlantic Ocean now occupied by the immense masses of marine plants commonly known as kelp. The absence of mammalia from any region does not particularly indicate that the land was unfitted for them, but that it was separated from the rest of the globe before mammalia appeared.

The Decline of Life-Insurance.—The English life-insurance agents are remarking upon the fact that a pause has come in the expansion of their business. This may be partly owing to a change in the general disposition to insure, in consequence of the growth of the idea that the same end may be reached by saving; partly by the increasing age at which the insuring classes marry; and partly by the vigorous and successful competition of American offices, which seem to be offering better security and better terms. The "Spectator" thinks that these causes are relatively insignificant, and that the main reason for the decline of insurance "is a desire on the part of the public for less trouble, more security, and better terms." It suggests that the companies regard themselves too much in the light of benefactors of the human species, and not as much as they ought in the light of tradesmen anxious for custom. "At present the insurer is treated as a swindler, to be

guarded against, and cross-questioned, and watched; and, as he seldom insures in complete free-will, but is compelled by his relatives, or his wife's relatives, or his creditors, he is unusually and unduly affected by his treatment." The minuteness of the medical inquiry required as a preliminary to insurance operates as a deterrent. The candidate does not like to have symptoms discovered by an over-zealous examiner which are invisible to laymen, and even to himself; "to have all his weak places found out; to stand a cross-examination from a man he did not select, and regards, for the moment, as an enemy, as to his habits of life; or to run the risk of the shock involved in a rejection, for reasons left unexplained." Insurance is a business in which a much slighter annoyance than this will turn a waverer, and induce him to resolve that he will save his money to himself. The value of the inquiry is, moreover, vastly overrated. The physician may be able to decide upon the candidate's bodily condition at the moment, but he can not decide what it will be three months hence, nor estimate "that quality of vitality which, and not health, is the question for the insurance-office." Persons who seem almost at the point of death frequently live for years; while those who appear most vigorous are as subject as any to quick death from fever. Persons also hesitate to insure because they can never understand the financial condition of the company, or satisfy themselves that they can get back the money they pay in premiums. More clear statements of accounts would commend the offices to a degree of confidence they do not now enjoy; and a provision by which the loss of premiums already paid in, in case of default, would be obviated, would go far toward strengthening the courage of the weak, and toward meeting the secret apprehension of the intending insurer that he might not be able to keep up his insurance.

Coeval Grades of Civilization.—A writer in "Blackwood's Magazine" has found, in the Island of Coll, of the Hebrides, evidence of the co-existence of widely removed degrees of civilization at an extremely remote antiquity. The storm of December, 1879, which caused the destruction of the Tay Bridge, also effected the removal of a few inches of sand from the bottom of a deep sand-valley near the castle, and exposed a number of old dwellings and human remains. Among the remains were kitchen-middens like those of Denmark, composed of littoral shells; bones and teeth of wild and domestic animals, split up for the sake of their marrow; chips of flint, all unpolished or palæolithic; and many fragments of rude, unglazed pottery. Along with these, in one of the heaps, were two curious bronze implements or ornaments, one of them a rich penannular brooch, of considerable beauty and finish, jeweled in twelve holes, and bearing distinct traces of having been gilt. The other ornament was a bronze pin, which had apparently been molded. Here, then, "at the most remote point of the prehistoric life of Coll to which we can reach, we find man, if a savage, still a person of taste, who could appreciate high art, and knew how to supply the wants of the dandy." These people carried on a commerce, for they had flints, which are not found in Coll, or anywhere near it, and were acquainted with the art of sailing, for their flints must have been brought from the south of England. The antiquity of the remains is estimated from their geological situation. They lie in the bottom of a shifting-sand valley, with large masses of sand around them, in a situation where no man would have ventured to settle if the sand had then been in the neighborhood to anything like the extent it is now. The sand is the result of the disintegration of the shells of snails which live on the island, and must, the most of it, have accumulated since the village was occupied. A palæolithic age and a considerable degree of civilization were coeval then in the Hebrides, and they are coeval there now. At Tiree, which is separated from Coll by a channel only two miles wide, *craggans* and other articles of pottery, exactly similar to these palæolithic ones of Coll, are manufactured and used at this day. "The old woman of Tiree, in this very year, takes the brown, stiff clay at her cabin-door, picks the pebbles out of it, pounds it down and softens it with a rude wooden mallet, molds it into shape with her rough, horny hands, and, without the aid of a potter's wheel, ornaments it, after a time-hon-

ored fashion, with a little stick or her thumb-nails; places the rude vessel thus formed — a kind of bowl or cup — in the strong heat of the sun, or before the blaze of the peat-fire, and so produces a rough, unglazed *craggan*, out of which she drinks her milk, and in which she infuses her tea. And all the while—let it be noted with all the emphasis at our command—several of her neighbors, with whom she is in daily intercourse, and with whom her teacher has been in daily intercourse, possess and use some of the finest ware that Leek or Burslem can produce. All round here, even in Tiree, are products of advanced art; but this native artist goes on her way unheeding all change and all advance, and turning out her unglazed ware as her ancestors had done—though probably in a superior style of art and workmanship—for perhaps thousands of years." Another fact to be noticed about these prehistoric remains is "that, of existing 'Celtic' brooches and penannular rings exhumed from great depths, the most highly finished, both in form and ornamentation, design and workmanship, are certainly the oldest," all showing that there has "at least been a relapse in a particular art."

Birds in Cold Weather.—M. F. Lescuyer has published some interesting observations concerning the power that was shown by the birds of his district of the valley of the Marne, France, for resisting the severe cold of the winter of 1879–'80. The sparrows, finding shelter and food around the houses, passed the season fairly well, but some of them perished in the roads and gardens; they became more scarce toward the end of the winter, and lost all their liveliness. The partridges gave way under sixty-one days of cold and hunger, and those that survived fell an easy prey to the hawks. A private watchman caught more than thirty with his hands, warmed them up, and let them loose again. The owls in the lofts and steeples could not resist the cold, and fell dead to the ground, or took refuge in the houses, where they were captured. The stomachs of all these birds were empty or nearly empty. The crows, which range over a larger extent of land than the former birds, which may be called sedentary birds, came nearer to the houses when the cold was at its worst, and considerable numbers of them were seen during the whole winter in the barn-yards and fields. Some of them came into the court-yards to eat with the pigeons, but many were frozen to death on the limbs where they roosted. The few birds of passage that staid in the country to winter showed very unequal powers of resistance. The bullfinches and grossbeaks did not seem to suffer, but the larks, yellow-hammers, greenfinches, robin-redbreasts, magpies, blackbirds, and jays were decimated. Never were so few birds seen in the woods at that season as in the following spring. Birds of passage, coming from the north to seek a milder climate in France, were disappointed. Domestic birds would have suffered greatly but for the shelter and feeding they enjoyed; fowls were worse affected than web-footed birds. The winter to which these observations relate was one of the severest ever experienced in France, and was very much like one of our Northern winters.

NOTES.

Dr. D. E. Salmon has pursued parallel investigations with those of M. Pasteur, of the microbe of hen cholera, and has conclusively satisfied himself of the accuracy of the results announced by the latter. He regards his researches as demonstrating that the virulent liquids of the fowl's body contain micrococci, that these can be cultivated, and that liquids in which bacteria are cultivated produce the disease by inoculation. His experiments indicate that the activity of the virus is destroyed at a temperature of 182° Fahr.

George H. K. Thwaites, Director of the Royal Botanic Garden at Peradeniga, Ceylon, died September 11th. He was appointed to the position in 1849, and in connection with it published in 1858–'64 an enumeration of the plants of Ceylon ("*Enumeratio plantarum Zeylanie*"). He was active in introducing to the island the cultivation of cinchona, tea, cocoa, Liberian coffee, and the India-rubber tree.

According to Mr. G. Macloskie, the elm-leaf beetle hibernates in cellars and attics in countless numbers. Three broods are brought forth in a season. This destructive insect is found only in the Eastern States and parts of New Jersey and Pennsylvania. Poison is the most complete remedy for it —one pound of London purple to one hundred gallons of water, squirted up into the tree.

LOUIS PALMIERI, Professor of Physics in the University of Naples and Director of the Seismological Observatory on Mount Vesuvius, has recently died, at the age of seventy-five years. He was appointed to the two posts in connection with which he has gained scientific renown in 1854, and has since pursued the study of earthquakes and the phenomena associated with them, with a real devotion. He was the inventor of an electro-magnetic seismograph, by which the most delicate indications of subterranean action could be detected.

M. POTEL has recently submitted to the French Society of Encouragement a new substance, which he has named, after himself, "poteline," and which appears to be susceptible of numerous applications. It is a mixture of gelatine, glycerine, and tannin, and is, according to the inventor, absolutely impermeable to the air. When warmed, it becomes liquid, or nearly so, and takes all the contours of an object. M. Potel has made corks of it, which form an economical substitute for metallic capsules, and secure an hermetic closing. He has used it as a coating to preserve meat. At a temperature of 112°, it envelops the meat, kills the germs of putrefaction, and prevents any new germ passing in. According to M. Potel, meat thus treated will retain all its freshness for two months.

ACCORDING to the experiments of M. Demarçay, the metals which are generally regarded as fixed, even iron, give out real vapors at relatively low temperatures. Cadmium, for example, volatilizes at 257° and zinc at 302°. Magnesia had already been found to be volatile below a red heat, when acted upon by water and chloride of silicon.

WITH the aid of M. Lippman's electrometer, M. Trousseau has succeeded in measuring the electrical conductibility of the poorer conductors, particularly of glass. Common glass is very perceptibly conductive, Bohemian glass is less so, while cut-glass has no sensible conducting powers. M. Dumas regards this classification as repeating from the electrical point of view the one which he has established as dependent on the presence of alkaline salts in the vitreous mass; of which cut-glass has none, Bohemian glass very little, and common glass a considerable quantity.

ADMIRAL COUNT FEODOR PETROVITCH LÜTKE, founder of the Russian Geographical Society and President of the St. Petersburg Academy of Sciences, died in August last. His name is identified to a considerable extent with the history of Russian polar and exploring expeditions, and with the discovery of some island groups in the Pacific. He had published narratives of his Arctic expeditions and of a voyage round the world.

THE fact that an aniline black can be formed with vanadium has provoked investigation into the feasibility of the production of that metal for commerce. MM. Osmond and G. Witz have found a considerable source of supply in the foundry-scorias of Creuzot, France, which contain two per cent of vanadic acid. The scorias have only to be treated with hydrochloric acid to obtain from them a green liquor which can be used directly in dyeing.

IT has been urged against the theoretical importance of the agency of insects in fertilizing flowers, that the insects relied upon are rare upon mountain-heights, where the flowers that should be fertilized by them are still abundant. The observations of M. Ch. Musset, of Grenoble, France, which range up to 10,000 feet in height, tend greatly to break the force of this objection. He finds that all the orders of insects are represented to the height of 7,400 feet, and that the number of nectar-seeking insects is proportionate to the number of flowers. The hours of wakefulness and of sleep of the nyctitropic flowers—the number of which is greater than is supposed—and those of the insects are synchronous. The apparent number of nectar-seeking insects, also, is related to the number of their favorite flowers.

JOHANNES THEODOR REINHART, Professor of Zoölogy at the University of Copenhagen, and Inspector of the Natural History Museum of that city, died October 23d, aged sixty-six. He was eminent in ornithology, and was author of a memoir on the birds of the Campos of Brazil, and of numerous papers in the scientific periodicals of Copenhagen.

M. BERGERON has produced imitations of the forms of lunar craters, by turning a current of gas into a melted metallic mass at the moment when solidification is about to begin. He obtained exact representations of the different varieties of hollows shown upon the moon by using different metallic mixtures.

PROFESSOR SOLLAS, of Bristol, has proposed to the British Association a scheme for securing a complete record of published scientific work, the essential feature of which is, that each nation furnish a record of its own work and of that only, and exchange with all other nations for their records. National committees are to attend to the preparation of the records, the transmission of exchanges, the translating and the composition of the records into a single work, and an International Congress is to take care of the uniformity and the successful working out of the scheme.

THE death is announced, at forty-three years of age, of M. Georges Leclanché, the inventor of the oxide of manganese constant elements.

HENRI MILNE-EDWARDS.